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THE OHIO ST. BASCULE BRIDGE AT BUFFALO, N. Y.

The Buffalo River at Buffalo, N. Y., like the Cuyahoga at Cleveland and the Chicago River at Chicago, affords ample opportunity for the display of ingenuity in the design of drawbridges to carry the very heavy street traffic across the congested waterways. The necessity for many and rapid openings of the draw has developed the inventive instinct to a high degree and the bridges found across these three rivers cover about all the various types of drawbridge construction, with the lift bridge predominating on account of the narrowness of the channels. Recently, however, there has been piers and abutments founded on pile footings. The 30-ft. roadway carries two interurban car tracks and there are two cantilevered sidewalks each 7 ft. 6 ins. wide. Both spans are built with two through riveted braced Warren trusses, 21 ft. deep between centers of chords, the fixed span being 100 ft. 6 ins. between supports and the draw 166 ft., with a clear waterway in the latter of 140 ft. In general outline construction the two spans are similar, but the fixed span is provided with concrete and brick sidewalks and roadway, while the drawspan has a floor surface of timber in order to reduce the weight of the movable span. Between the shore and the pier upon which is set the pin about which the the truss along such a curve that the moment of the dead load of the bridge around the trunnion and that of the cable stresses around the same point must remain equal in any position of the moving portion. Thus the only duty imposed upon the motive force is to overcome the frictional resistance of the moving parts and the force of the wind against the floor of the rising or lowering bridge.

In the bridge herein described, Fig. 5 illustrates the general scheme of operation. The actuating mechanism is applied separately to each truss and controlled from a single lever so as to ensure simultaneous operation. First, in the counterweighting system, the curve F E is

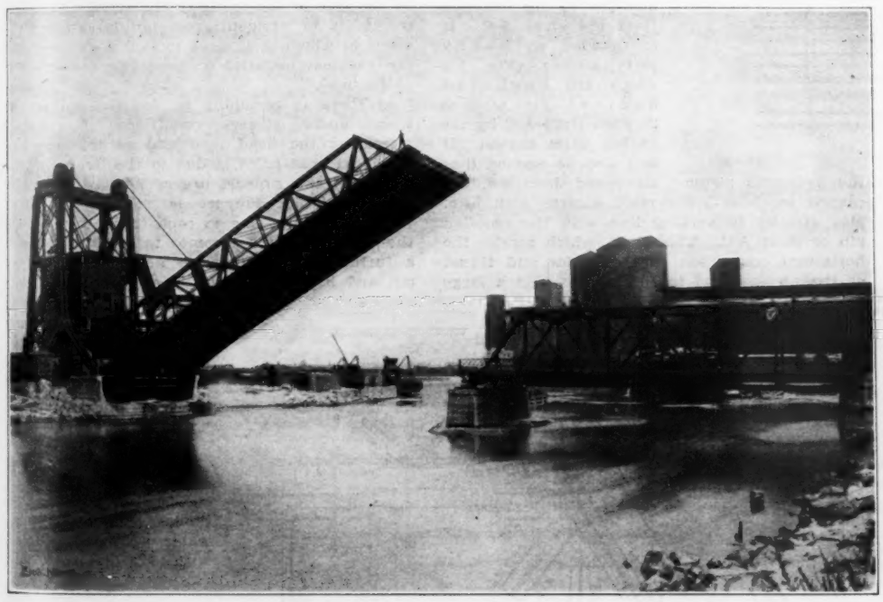


Fig. 1. Bridge Partially Raised.

Fig. 2. Bridge at Full Inclination.

THE OHIO STREET BASCULE BRIDGE ACROSS BUFFALO RIVER, BUFFALO, N. Y.

Thos. E. Brown, M. Am. Soc. C. E., Inventor. C. M. Morse, M. Am. Soc. C. E., Deputy Engineer Commissioner of Buffalo.

finished, on the line of Ohio St. across the Buffalo River, a bascule bridge, after the patented design of Mr. Thomas E. Brown, M. Am. Soc. C. E., which is different in many features from any of the previously erected types. The design after which the Buffalo bridge is patterned was first devised by Mr. Brown for the prize competition for the bridge across Newtown Creek in Brooklyn, N. Y., in 1896. (Eng. News, Nov. 5, 1896, p. 292.) It was awarded the prize at that time, but before construction could begin the formation of Greater New York made invalid all proposed public work upon which contracts had not been signed, and the construction of the bridge as first designed was never carried out.

The bridge at Buffalo consists of a fixed and a draw span each resting on mass concrete moving span revolves, the floor system is carried upon two 52-ft. plate girders which also act as supports for the tower that carries the counterweight system and the engine house. This short span is covered with a brick and concrete flooring similar to that on the fixed 100-ft. span.

METHOD OF OPERATION.

The Brown patent depends primarily upon the fact that practically the entire dead load of the bridge is taken away from a vertical reaction on the abutments and supported by a counterweighted cable passing over a tower back of the fixed end. The bridge is raised by applying power horizontally on the lower end of the end strut of the fixed end, thus revolving the span around a pin higher up on this same end strut. The cable supporting the dead load is attached to a grooved track around which bends the cable fastened below to a pin at "D" and above over a sheave to the counterweight sliding in guides on the tower back of the moving span. This grooved track is arranged so as to prevent the cable from moving inward toward the tower but not outward toward the free end of the bridge, so that as the moving span rises, the upper part of the cable will leave the guide, gradually covering a smaller portion of the curve and increasing the angle with the lower line of cable. The curve was so designed that the resultant stress in the cable has the same moment around the turning pin as the dead load of the moving span. To raise the bridge, a horizontal force applied by a hydraulic piston, at "B," turns the truss around the pin "C." As the mechanical details in applying a load

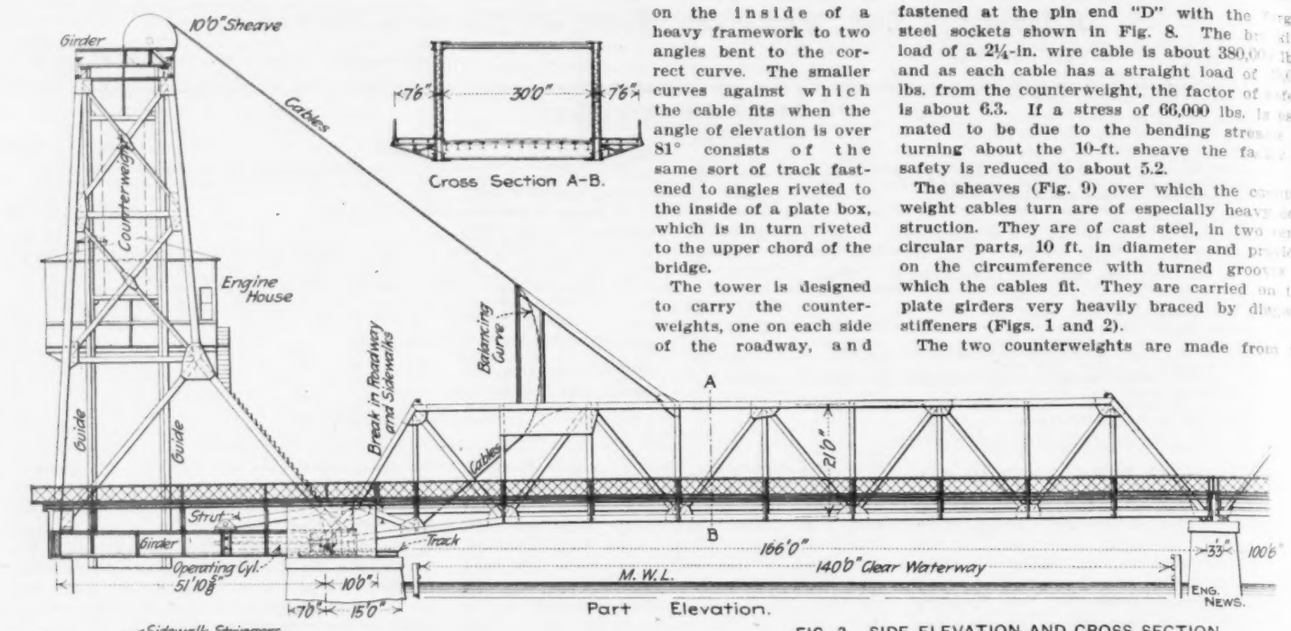
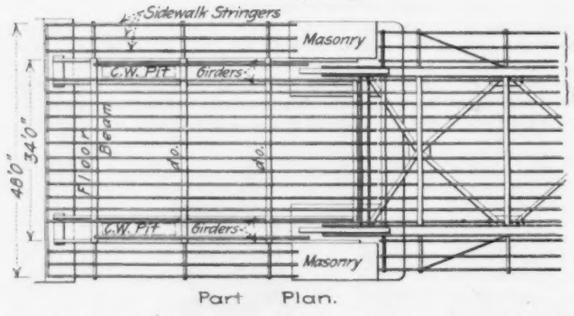


FIG. 3. SIDE ELEVATION AND CROSS SECTION OHIO ST. BASCULE.



from the piston on a horizontal line are much more simple than those necessary in applying the load along a curve such as "B" would travel if "C" were fixed, it became necessary to attach "C" by a link back to the fixed framework of the counterweight tower. The movements of the various parts, in raising the bridge, will thus be seen to be as follows: "B" runs in a horizontal line outward, "D" with the rest of the bridge moves in a curve around the moving point "C," which moves in the arc of a circle around "A" controlled in vertical travel by the fixed strut B C.

It will be noted that as the moving span is raised the center of gravity of the bridge approaches the center of moments used, until at about an elevation of 81° from the horizontal the vertical through the center of gravity, passes through the center of moments. Beyond this point then the span has a tendency to move backward, which the counterweight must be made to counteract. Therefore two channel guides at "F" and "G" were riveted to the trusses so that at the higher angles of the rise the counterweighted cable holds the bridge from against the towers. This position is shown dotted in Fig. 5.

STRUCTURAL DETAILS.

The steelwork presented no particular difficulty and was designed according to current practice. All joints are riveted, though a slight complication was caused by the necessity for pins at the lower fixed end of the trusses. As will be noted in Fig. 4, these pins were introduced to permit of the movement in the cable joints and raising levers and in no way act as pin joints in caring for the load stresses in the trusses, although they necessitate much heavier riveted joints where they are placed. These pins were 12 ins. in diameter at "A" and "C", 10 ins. at "B" and 8 ins. at "D."

Fig. 8 shows the framing of the braced curve against which the cables react. This consists of a cast steel track with planed grooves bolted on the inside of a heavy framework to two angles bent to the correct curve. The smaller curves against which the cable fits when the angle of elevation is over 81° consists of the same sort of track fastened to angles riveted to the inside of a plate box, which is in turn riveted to the upper chord of the bridge.

The tower is designed to carry the counterweights, one on each side of the roadway, and the machinery house, in addition to the reaction from the strut A C. It is founded on heavy plate girders (Fig. 10) which are anchored against the stresses through strut A C by the anchor bolts shown. It will also be noticed that the hydraulic pistons, afterward described, are pinned to these same plate girders with 5-in. pins directly in vertical line with the reaction pin of strut A C. This strut, which carries the horizontal component of the cables and thrust of the pistons, and in the 90° position a large static tension, is designed especially heavy, in H-section, the length of the latticing or the spacing of the longitudinal members decreasing toward the drawbridge end (Fig. 6).

The cables consist of six 2¼-in. steel wire cables to each counterweight of 360,000 lbs., fastened at the pin end "D" with the Angel steel sockets shown in Fig. 8. The breaking load of a 2¼-in. wire cable is about 380,000 lbs., and as each cable has a straight load of 60,000 lbs. from the counterweight, the factor of safety is about 6.3. If a stress of 66,000 lbs. is estimated to be due to the bending stress in turning about the 10-ft. sheave the factor of safety is reduced to about 5.2.

The sheaves (Fig. 9) over which the counterweight cables turn are of especially heavy construction. They are of cast steel, in two semi-circular parts, 10 ft. in diameter and provided on the circumference with turned grooves in which the cables fit. They are carried on two plate girders very heavily braced by diagonal stiffeners (Figs. 1 and 2).

The two counterweights are made from the best quality gray cast iron and weigh 180 tons apiece. It would have been cheaper to have made them of an iron concrete or a poorer grade of cast iron, but the desirability for placing them at the side of the roadway (to avoid the remote possibility of accident from falling) limited the space in which they move to such an extent that the heaviest material economically possible had to be used.

As there is no uplift at the far end of the span under correct conditions of counterweighting the dead load and as the only reaction at that point is due to the live load, the details of the support are of no particular importance. The support is made with small webbed castings, one to each truss, upon which the end of the truss comes to rest. To ensure a further rigidity there is also a hand driven pin and hole lock which is operated from that end of the bridge (Fig. 4). Swing gates closing simultaneously the roadway and sidewalks and operated at the gate by hand are provided at both ends of the draw.

MACHINERY.

The machinery layout is shown in Fig. 7. It consists of two steam pumps each of 400 lbs. water pressure capacity, with 12-in. steam cylinder, 6-in. water cylinder and 12-in. stroke, situated with most of their pipes and valves in a house above the roadway in the tower. These pumps maintain pressure in high and low pressure tanks from which the water under pressure is conveyed through the control valve to a 28-in.

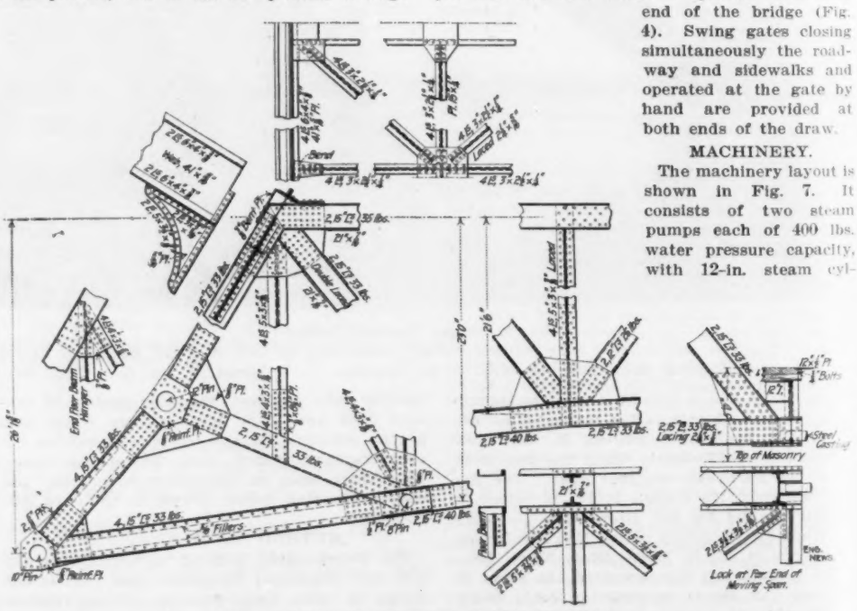


FIG. 4. DETAILS OF STEEL WORK AT PINS.

piston on each truss. The control is through a wheel controlled valve set (Fig. 6) by means of which the water under pressure may be led to either the front or back of the piston or can be held in the pipes. In raising the lift the valve is first set so the pressure is forced to the back of the piston and when sufficient momentum has been acquired in the rising bridge to carry it to the point desired, the valve is set to mid-position and the check-valve permits the passage of the water through the pipes without the sudden reaction that shutting off the water in front of the piston would cause. The motion of the bridge beyond 81° is retarded by the cables acting against the curved tracks noted above, and the bridge is prevented from moving back against the tower. The maximum power of the machinery is required to move it to 90° The entire operating system is well housed with the steam plant so that a temperature of 60° to 70° F. is always maintained around all the water connections. Therefore it has not been necessary to use any non-freezing mixture in the hydraulic pressure system; water from the city taps is used the year round.

While this hydraulic motive power is not necessary in this style of bridge, it furnishes an admirable mechanism which gives an efficient control of the moving span. Certain local conditions precluded the use of electric motors at this bridge, although on account of the 24-hour day in which it is in operation, such control would have doubtless been very economical. It is therefore necessary here to keep steam up during the entire day and night. But with the hydraulic power the engineman has only to keep his pressure tanks to the proper gage and does not have to have his boiler always ready for the duty imposed by the lifting span, as would be necessary in a steam-driven cog and gear system.

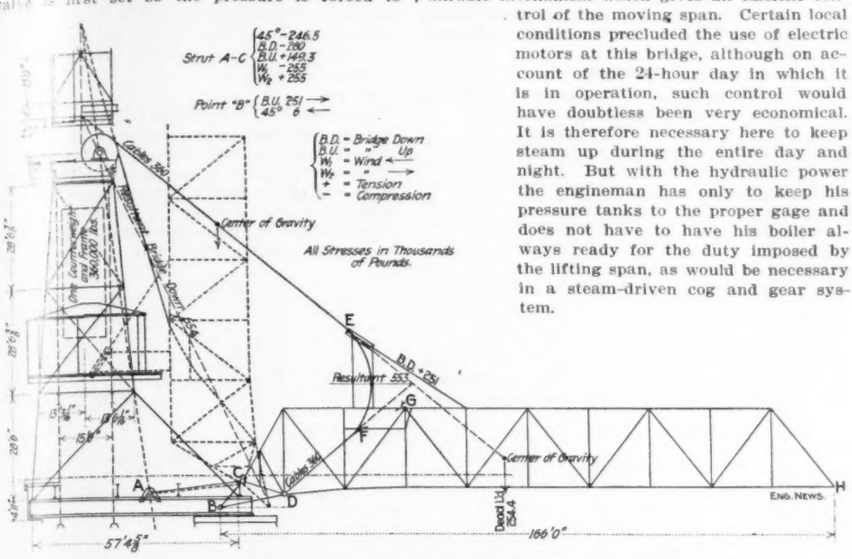


FIG. 5. DIAGRAMMATIC ELEVATION OF OHIO ST. BASCULE.

The pin "B" is connected to the piston shaft by an ordinary crosshead (Fig. 6) which slides upon a track in the raising of the bridge. This track consists of a cast rail, anchored into a concrete base and capped with a polished steel sliding surface. The whole track is well protected from the weather and with careful attention, should keep in as good condition as most engine cross-heads.

22 ft. c. to c. with 10 tons on each axle. In addition in raising the bridge a wind load of 5 lbs. per sq. ft. was assumed on the surface of the movable span. In computing the machinery required the coefficient of axle friction assumed was 0.05 and that for sliding friction 0.08. It has since been shown in operation that these friction values are probably about 25% in excess of actual working coefficients.

The stresses in the draw span are somewhat complicated owing to the inclination of the supports and the changing nature of the thrusts as the elevation of the bridge changes. The various reactions may be explained as follows. The stresses, of course, are quite easy of computation when the reactions are once determined. The loads and stress given are all for one truss. When the bridge is down the live load is distributed, with 155,000 lbs. to "B" and 150,000 lbs. to "H," as vertical reactions; the inequality being due to the unsymmetrical truss. The dead load conditions are a load of 254,400 lbs. at the center of gravity of the bridge, a counterweight support of 360,000 lbs., the unknown stresses in A C and the reaction at "B." It is assumed that no dead load reaction can come to "H." Then by taking moments about "B" the stress in A C is found to be a compression of 280,000 lbs., the maximum static compression in that strut under any position or condition of loading. The vertical component of this stress, added to the cable vertical component still leaves 12,000 lbs. as an uplift reaction at "B" in order to offset the 254,400 lbs. dead load. The horizontal component of A C is equal to the horizontal component of the cable stresses so no horizontal thrust comes at "B" under dead load with the bridge down. Proceeding similarly for the other angles of inclination it is found that there is in each case small horizontal inward thrusts and negligible vertical uplifts at "B" until the center of equilibrium is past when the stress in A C is reversed and at 90° elevation there is a tension of 149,000 lbs. in A C and an outward horizontal thrust at "B" of 244,000 lbs. This is the maximum thrust coming upon the cylinder head and is offset by the hydraulic pressure of 246,400 lbs. when the 28-in. piston is working to its full 400 lbs. per sq. in. capacity. The tendency to rise at "B" is offset by the crosshead held to its running rails.

The stresses for all members were computed both analytically and graphically for different inclinations of the draw and the maximum taken for the computed section. A wind load of 5 lbs.

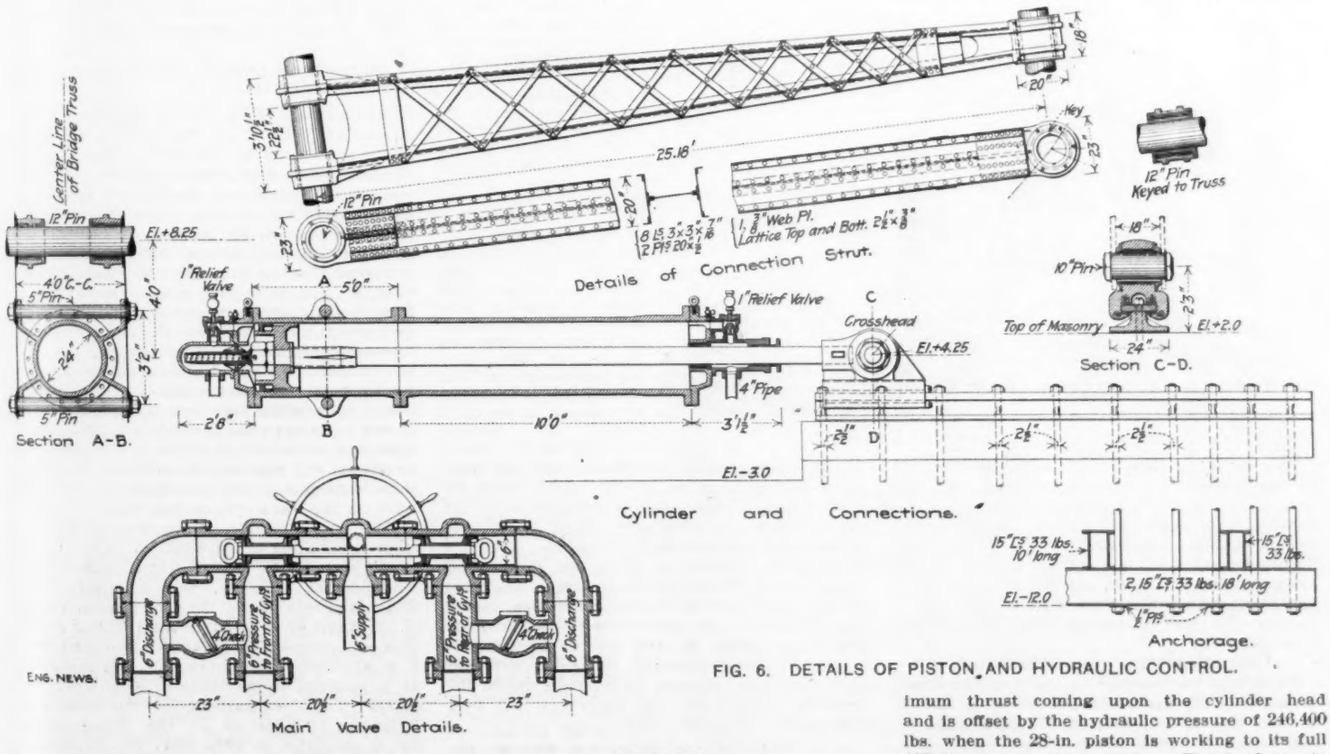


FIG. 6. DETAILS OF PISTON AND HYDRAULIC CONTROL.

STRESSES.

In computing the stresses the following assumptions were made: Live load of 100 lbs. per sq. ft. of roadway and sidewalk or a wagon load of 12 tons on two axles 10 ft. c. to c. or again two cars each with a truck of two axles spaced 6 ft. on centers, the centers of the trucks being

per sq. ft. was also added, but against wind pressure above that the rated capacity of the pumps can not act. It might be stated, however, that the draw has been operated in a gale blowing 45 miles per hour against the floor of the bridge. This wind was at a slight angle to the line of the bridge, however.

Figs. 1 and 2 are half-tones taken from photographs of the draw in operation and indicate better than any line drawing or description the massive character of the construction as well as details of the design. Particularly to be noticed on these half-tones are the nature of the floor system and lower lateral bracing, and the skeleton character of the draw-span abutment which acts principally as a face wall to enclose the draw pit. The city proposes to build a wall across the front of this pit to more completely enclose it.

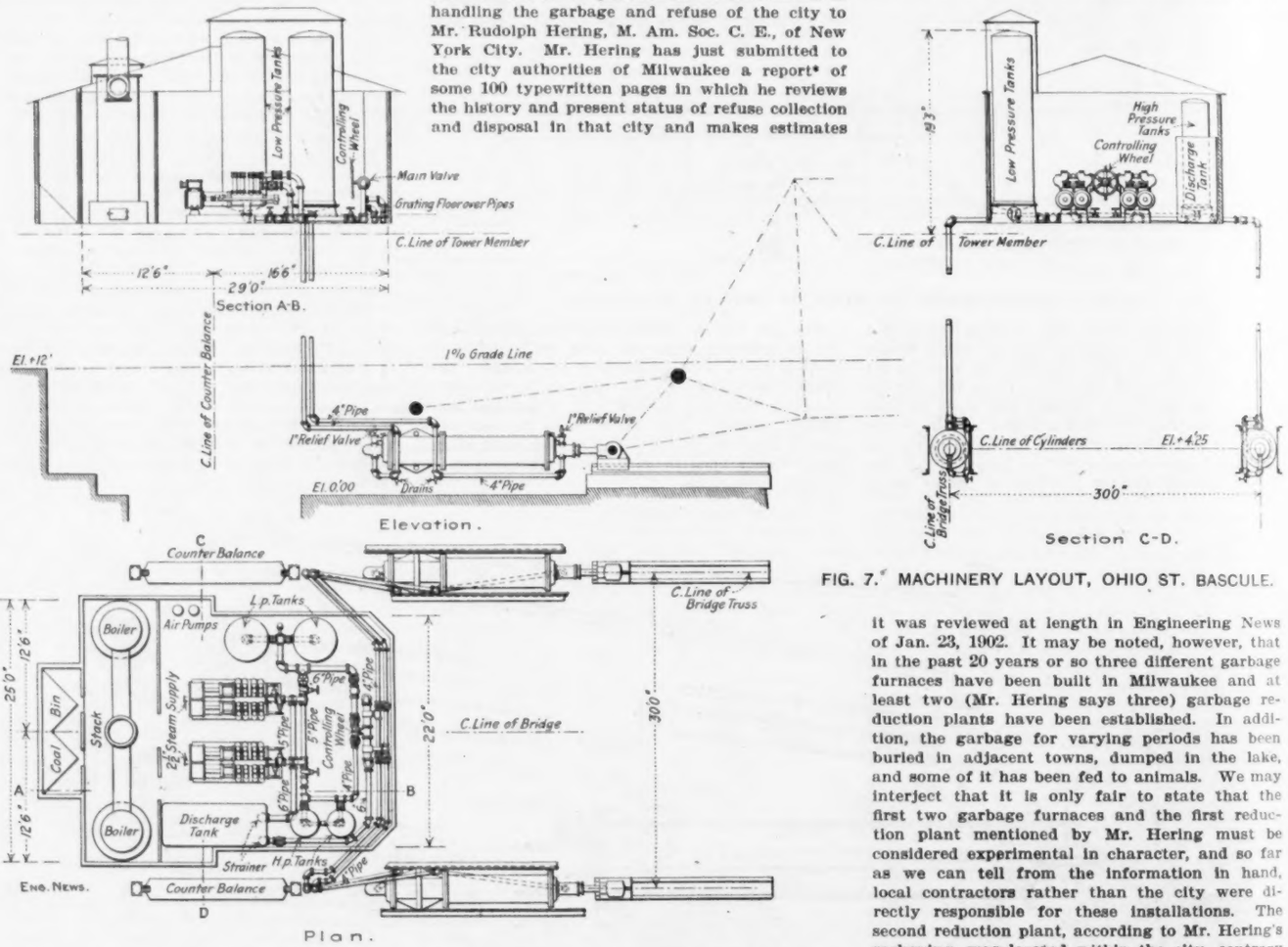


FIG. 7. MACHINERY LAYOUT, OHIO ST. BASCULE.

The bridge is intended to move from 0 to 85° in one minute, but has been operated through this arc in about 30 seconds. It has given the greatest satisfaction both from an economical and mechanical standpoint. Its cost has been about the same as the similar bridges in use along the Buffalo River, and in its operation it has been, if anything, more easy to control and smoother in its movements than any of the others.

ENGINEERING ORGANIZATION.

The design was selected by the Engineer Commissioner of the city of Buffalo, Mr. C. M. Morse, M. Am. Soc. C. E., after due consideration of the merits of many other bridges which had been submitted to him for this location. It was erected under his supervision with Mr. G. H. Norton as Engineer in Charge. Mr. Thomas E. Brown, M. Am. Soc. C. E., and the Osborn Engineering Co. were Consulting Engineers and the Pittsburg Steel Construction Co., general contractors. The machinery was furnished by the Howard Iron Works branch of the Otis Elevator Co. The contract price for superstructure and machinery was $117,700, which included plans and rights. The contract for the substructure, including some rock excavation in the channel, dock construction and paving work on the approaches, cost $59,200.

We are indebted to Messrs. Morse and Brown for the information and drawings herewith given.

REPORT ON GARBAGE AND REFUSE DISPOSAL, MILWAUKEE, WIS.

The infrequency with which American cities consider garbage and refuse disposal as an engineering problem has often been commented on in these columns. It is therefore a pleasure to note that the city of Milwaukee, after chance trials of various methods of disposal, recently referred the broad question of the best means of handling the garbage and refuse of the city to Mr. Rudolph Hering, M. Am. Soc. C. E., of New York City. Mr. Hering has just submitted to the city authorities of Milwaukee a report* of some 100 typewritten pages in which he reviews the history and present status of refuse collection and disposal in that city and makes estimates and recommendations for dealing with garbage, ashes and other refuse in the future. This report is one of a very few of the kind made for an American city. The only others at all comparable with this one that we can now recall are the Columbus report, in which Mr. Hering had a hand (Eng. News, March 15, 1906); the East Orange report by Mr. Henry Floy (Eng. News, Jan. 24, 1907), and recent reports by Mr. J. T. Fetherston, Assoc. M. Am. Soc. C. E., Superintendent of Street Cleaning, Richmond Borough, New York City (recently summarized before the American Society of Civil Engineers; see Proceedings for November, 1907).

As a result of the Milwaukee studies, Mr. Hering recommends that the garbage, ashes and rubbish of Milwaukee be burned together in furnaces with a total capacity of 450 tons per day, or that if the city desires to save present expense it limit the initial installation to a 300-ton plant in which the garbage and the most objectionable portion of the other refuse would be burned. Mr. Hering concluded that a reduction plant with a furnace to burn the most objectionable portions of the refuse other than garbage, would be more expensive than furnaces to handle all classes of refuse, taking into account the extra transportation of garbage to a reduction plant, and also allowing for the revenue to be derived from utilizing the heat produced by burning the refuse.

In opening his report, Mr. Hering states that Milwaukee has perhaps had the most varied garbage disposal experience of any city in the country, and he adds that the subject has entered into political campaign agitations several times during the past 20 years. He devotes considerable space to reviewing the history of garbage disposal in Milwaukee, but it is unnecessary to go into that subject in detail here, since it was reviewed at length in Engineering News of Jan. 23, 1902. It may be noted, however, that in the past 20 years or so three different garbage furnaces have been built in Milwaukee and at least two (Mr. Hering says three) garbage reduction plants have been established. In addition, the garbage for varying periods has been buried in adjacent towns, dumped in the lake, and some of it has been fed to animals. We may interject that it is only fair to state that the first two garbage furnaces and the first reduction plant mentioned by Mr. Hering must be considered experimental in character, and so far as we can tell from the information in hand, local contractors rather than the city were directly responsible for these installations. The second reduction plant, according to Mr. Hering's reckoning, was located within the city, contrary to present-day practice for reduction plants. All three reduction plants mentioned in the report were on the Merz system (see Eng. News, Nov. 1, 1894, for a detailed description of the latest Merz installation at Milwaukee). The first garbage furnace, the report states, was built for experimental purposes, was installed by Mr. Engle, and was one of the very earliest furnaces of the Engle or of any type built in this country. This was followed by a furnace promoted by Dr. S. S. Kilvington, of Minneapolis, and is described as a modified Engle furnace which cost about $3,000. The third garbage-burning plant was a Robinson modification of the Engle furnace, put in operation in 1902, after five as troublous years with garbage disposal questions as any American city ever had. This Engle plant had a guaranteed capacity of 150 tons per day (see Eng. News, Jan. 23, 1902, for a fully illustrated description). This plant has been in continuous operation since its installation, except when stormy weather prevented the transportation of garbage by boat to the island on which it is

*The report has been printed in Proceedings of the Common Council of Milwaukee for Dec. 23, 1907.

located and except for periods of varying length in winter when it was necessary to shut down the plant for repairs owing to the lack of reserve capacity. The location of the plant on the island was regarded as a mistake, and this mistake Mr. Hering proposes to avoid by having the proposed new plant installed on shore near by. The transportation of the garbage by barge necessitates the use of a hoist, engine, etc., for transferring the movable garbage wagon boxes to and from the wagons and the barges. These transfers, besides expense, cause delays. Mr. Hering says that the furnace has been "in a measure successful" and has demonstrated that garbage can be burned at Milwaukee. But the furnace is costly to operate, requires much extra fuel and does not utilize the heat.

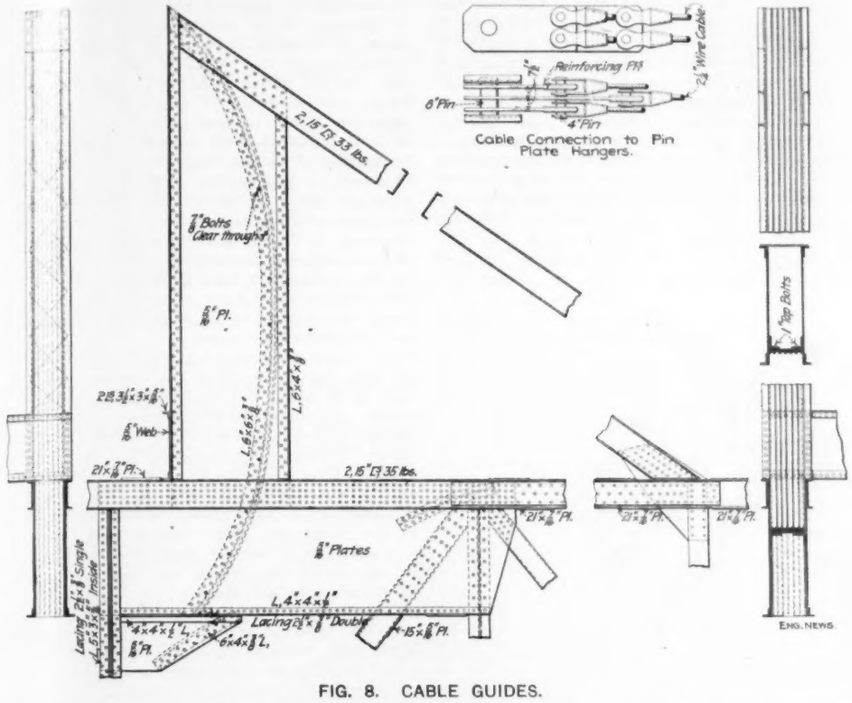


FIG. 8. CABLE GUIDES.

Ashes have been collected for over 30 years in Milwaukee at public expense, and used for filling. The collection of rubbish, except as it was mixed with ashes, was not attempted until 1907. Rubbish also is now used as filling and so are street sweepings, which are collected by ward teams. The city did nothing in the way of providing for the disposal of stable manure until 1907, and then all it did was to arrange with a railway company to station cars in the center of the city, to which private contractors can deliver garbage to be hauled to county institutions and used as fertilizer. The health department thinks that stable manure will soon give trouble in hot weather. Mr. Hering remarks that this manure can be burned and that the American Express Co., of New York City, is now building a furnace for that purpose.

In taking up his estimates of the cost of garbage and refuse disposal in Milwaukee, Mr. Hering first noted that the city has an area of 22¼ sq. mi. (4 × 6.5 miles), and that there is a general descent in most parts of the city to the present and proposed garbage furnace sites. The estimated population of Milwaukee is 350,000, as compared with 290,000 shown by the U. S. Census of 1900. The garbage and small dead animals collected in 1906 totalled 48,397 loads, or 38,550 tons. Of this tonnage 35,245 tons were burned in the garbage furnace and the remainder was buried. The quantity of garbage collected by months ranged from 2,381 tons in December to 4,427 in August. On the basis of 310 working days per year, an average of 125 tons per day was collected.

It being desirable, for a comparison of reduction and cremation and for other purposes, to know the composition and calorific power of the garbage of Milwaukee, Prof. R. E. W. Sommer, of Milwaukee, was employed to investigate this subject. In view of the scantiness of such data, we reprint Professor Sommer's report in full:

In order to obtain an average sample, the city was divided into five districts, according to the wealth of the population. It was ascertained how many team loads are collected during the same length of time (one month) in each of these five districts. When the teams arrived, Sept. 9, 1907, there were taken as many unit measures (garbage cans) of the garbage of each of the five districts as the district gave teams within the same time The garbage was poured upon a sloping hard floor and well mixed with a spade.

In order to determine the amount of liquid which is pressed out by the weight of the garbage, a weighed quantity of the mixed garbage was filled into a barrel having a double perforated bottom, and allowed to stand for 24 hours, and the liquid which drained off was weighed.

The larger quantity of the mixed garbage was piled up and quartered down, just as miners do in order to obtain an average sample of ore. After each quartering, the garbage was comminuted with knives, and the quartering and comminution continued until 25 lbs. of garbage were obtained. The liquid pressed out by these processes ran down the sloping floor and was collected, measured and each time calculated in the right proportion. The remaining 25 lbs. of mixed comminuted wet garbage were brought to the chemical laboratory. Here the quartering was continued until about 2 lbs. were obtained. The approximate 2 lbs. were accurately weighed and heated on a water bath for some days, until they appeared dry, and the drying process continued in a drying oven at 105° C. until constant weight. The loss of weight plus the weight of the liquid (proportionately calculated for 2 lbs.) which was squeezed out by the process of comminution gave the total amount of water.

The dry garbage was poured in an iron mortar and gave a coarse, brownish-black powder, somewhat resembling ground coffee. The chemical analysis was made with this powder.

The analysis of the wet garbage was computed from the analysis of the dry garbage and the total water.

ANALYSIS OF DRY GARBAGE.

Pounds in 100 lbs. of garbage:	
Ash	61.88 lbs.
Combustibles	38.12 "
	100.00 "
Grease*	8.775 "
Nitrogen	1.61 "
Glucose, obtained by inversion of starch	12.50 "
Phosphoric acid (P_2O_5)	2.31 "

*Of a brownish-black color, having a saponification value of 190.

One pound of dry garbage on combustion gives 4,522 B. T. U. of heat.

ANALYSIS OF WET GARBAGE.

Total water	78 lbs.
Dry garbage	22 "
	100 "
Ash	13.614 lbs.
Combustibles	8.386 "
Grease	1.93 "
Nitrogen	0.354 "
Glucose, obtained by inversion of starch	2.75 "
Phosphoric acid (P_2O_5)	0.508 "

DETERMINATION OF FREE MOISTURE.

The time for the determination of the free moisture was 24 hours. The height of the pile was determined by placing the stated weight of garbage in a salt barrel.

The following are the results of the tests of garbage for the free moisture, drawn off without pressure, except its own weight:

Sept. 17, 50 lbs. garbage.. ½-pint = 3⅛%, height, 8"
Sept. 18, 100 lbs. garbage.. 7⅛ pints = 7⅛%, height, 16"
Sept. 19, 150 lbs. garbage..14 pints = 9⅓%, height, 24"
Sept. 20, 200 lbs. garbage..15 pints = 7½%, height, 32"

Hence, the maximum quantity of water which the garbage can press out by its own weight is 9⅓% of the weight of the wet garbage, and this pressure is reached by the height which 150 lbs. of wet garbage occupies in a barrel, which is 24 ins. A greater height of the garbage presses the lower portions of the garbage too much; the lower portions becoming too dense, do not permit the liquid to pass through.

As the total quantity of water in 100 lbs. of garbage is 78 lbs., 68⅔ lbs. of water need heat for evaporation.

CALCULATION OF BRITISH THERMAL UNITS TO BE ADDED AS COAL, IN ORDER TO BURN 100 LBS. OF WET GARBAGE.

Each kilogram of water requires 536.4 calories for evaporation.

As one calory equals 3.9694 B. T. U.:

1 kg. of water requires for evaporation 536.4 × 3.9694 B. T. U., or 2,129.2 B. T. U.

1 gram of water, therefore, requires 2.1292 B. T. U. for evaporation.

As 1 lb. equals 454 grams: 1 lb. of water requires 454 × 2.1292 B. T. U., or 966.66 B. T. U. for evaporation.

100 lbs. of wet garbage contain, according to analysis:

Dry garbage	22 lbs.
Water which is pressed out when the garbage is piled up 24 ins. high	9⅓ "
Water which the garbage cannot press out by its own weight	68⅔ "
	100 lbs.

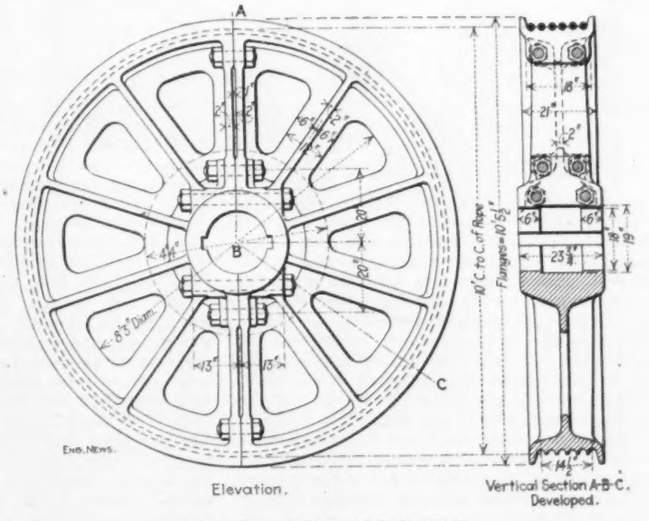


FIG. 9. DETAILS OF SHEAVE.

Hence, 68⅔ lbs. of water must be evaporated by heat. As 1 lb. of water requires 966.66 B. T. U. for evaporation, 68⅔ lbs. require for evaporation 68⅔ × 966.66, or 66,371 B. T. U.

We must also add the heat required for heating the pressed garbage from the average temperature (45° F.) of the city of Milwaukee to the boiling point of water (212° F.), and this was made as follows:

68⅔ lbs. of water when heated from 45° to 212° F. equal 167°, require 68⅔ × 167, or 11,456 B. T. U.
22 lbs. of dry garbage when heated from 45° to 212° F. equal 167°, require 22 × 167 × 1.21, or 4,346 B. T. U.

The number 1.21 was experimentally determined by me. It represents the B. T. U. necessary to heat a pound of dry garbage 1° F. Therefore, the total amount of heat required for heating the wet garbage from 45° to 212° F., and the subsequent evaporation of water is 66,371 + 11,456 + 4,346, or 82,173 B. T. U.

As 1 lb. of dry garbage on combustion gives 4,522 B. T. U., the 22 lbs. of dry garbage contained in 100 lbs. of wet garbage would generate 22 × 4,522, or 99,484 B. T. U.; that is, the heat produced by the combustion of the dry garbage contained in 100 lbs. of wet garbage is far greater than the heat required for evaporation of the water and the preceding heating of the wet garbage from 45° to 212° F., or in other words: *The wet garbage, after the free moisture has been removed by its own pressure, should burn itself without the addition of coal.*

Practically, this calculation should be somewhat modified, by adding also the heat required for heating the formed ashes and the heat required for heating the formed combustion gases to the temperature of 1,500° F. which they possess when they pass out of the chimney, but this calculation cannot be made without a chemical analysis of the chimney gases.

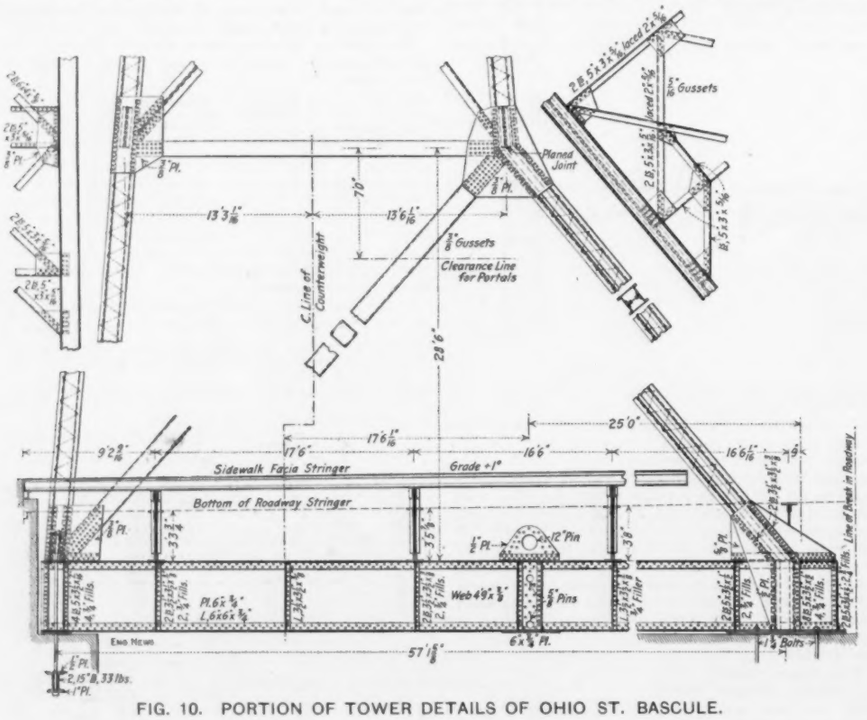


FIG. 10. PORTION OF TOWER DETAILS OF OHIO ST. BASCULE.

From the foregoing report and his own observations Mr. Hering concludes

that under proper management and in proper furnaces there should be no difficulty in burning the [Milwaukee] garbage alone without fuel the most of the year.

The garbage of Milwaukee is now collected in 270 wagons, having removable boxes weighing about 575 lbs. each and costing $50 apiece. The boxes are of iron, 3 ft. wide, 6½ ft. long on top and 9 ft. on the bottom, and 1 2-3 ft. deep. The city owns and repairs the boxes, but the collectors furnish horses and wagons.

The fuel cost of operating the Engle furnaces for the year 1906, using (chiefly) Hocking Valley coal at an average cost, delivered at the dock, of $3.78 per ton, and using 160 lbs. of coal per ton of garbage, was 19 cts. per ton of garbage. An electric motor blows air into the garbage furnace above the fire. The current for this motor and for lighting the garbage plant is drawn from the adjacent sewage pumping station, without credit to the latter.

Mr. Hering states that there have been no complaints of odor from the garbage furnace chimney, and that judging from the furnace ashes combustion is complete. The estimated amount of residual ash, etc., is 8 tons for each 150 tons of garbage, but this includes the ashes of the coal used as fuel. The air blast, Mr. Hering states, is wrongly introduced, the draft is not always under control, the furnace is too small at the height of the season, there is no opportunity for repairs without shutting it down, and economical operation is impossible.

The total cost of garbage collection and disposal in 1906 was $116,936; collection alone, $63,837; operating the hoist, $3,731; operating the furnace, $47,816; burial, $551. Included in the item given for hoist expenses are repair of the scows and of the hoisting engine, and also the cost of transporting garbage across the river to the island, except that no allowance is made for the service of fire-boats as tugs, which, it appears from the report, took most of the work of towing. The cost of operating the furnace plant includes the repair of garbage boxes.

Studies of hauling garbage made in September, 1906, taking into account the distances traveled by 17 representative collectors, out of a total of 95 collectors, showed that the average distance traveled by each collector in one day was 7.2 miles, not including the distance from the collector's home to the point of beginning the first load and of discharging the last one. Each collector handled only two 0.8-ton loads per day, or a total of 1.6 tons. In 1906 the men were paid $1.25 per load and in 1907 $1.50 per load, so that on the two-load-per-day basis the cost of collection for the average mileages given was 22 cts. and 26 cts., respectively, per ton-mile.

The report contains a number of tables analyzing the quantities and costs of ashes and general rubbish collected in 1906. The average haul in miles, reckoned from the center of each district, ranged from ½ to 3 miles; the size of wagon loads varied from 2 to 4 cu. yds., but most of the wagons had a capacity of 2½ or 3 yards.; the number of loads hauled per day from each ward ranged from 11½ to 28, and the cost per load from $1.42 to $2.10; the cost per ton ranged from $1.09 to $1.72 and averaged $1.31 per ton. The city hires men with wagons for $4 per day for eight hours' work, and owns about 20 wagons for collecting ashes and rubbish. The ashes and rubbish collected at intervals ranging from 2 or 3 to 5 or 6 weeks, depending upon the character of the population and the time of the year.

The average cost of hauling garbage to the foot of Erie St. in 1906 was $1.54 per ton. The garbage was hauled to about the same point as Mr. Hering recommends for the location of the new refuse furnace.

The weight of various classes of refuse named in the preceding paragraph is given in the report as follows, all figures being based on an average load of 2½ cu. yds.: Ashes and rubbish mixed, 2,600 lbs.; dry manure, 2,425 lbs.; clean ashes, 3,025 lbs.; rubbish, alone, 1,625 lbs.

The amount of horse manure produced in Milwaukee is estimated at 267,000 lbs. per day, this being based on an average of 21½ lbs. per horse, actually produced by 6 horses.

In considering the relative advantages of the disposal of the garbage alone by reduction and by burning, it is assumed that the garbage would be transported to the site of the reduction works, outside the city, and that for this purpose rail (15 miles) rather than lake (20 miles) transportation would be required. Lake transportation would be less expensive, but is considered undesirable on account of possible interruptions of the lake service in rough weather. The cost of rail transportation to a reduction plant is placed at 70 cts., of which 60 is for transportation proper and 10 cts. for loading into the cars. This 70 cts. is an addition to the cost of transportation for disposal by burning, owing to the assumption that if furnaces were used they would be located close by the point at which the garbage would be transferred for shipment to reduction works.

The value of ashes for fuel purposes at refuse furnaces was taken as 75 cts. per ton, assuming coal at $3.75 per ton, and that 20% of the domestic ashes are unburned coal. Rubbish was assumed to have the same fuel value per ton as ashes. It was also assumed that with a fuel value of 75 cts. per ton for rubbish and for ashes, and an average hauling cost of 25 cts. per ton, it would pay to haul these materials three miles to the furnaces. The average haul, however, was assumed to be only about two miles, and it is also noted that there are sanitary reasons for burning the rubbish.

Even though reduction be not adopted, it is deemed advisable to collect the garbage separately, both because the garbage should be collected much more frequently than other classes of refuse and because, as shown by Professor Sommer's report, the garbage may be deprived of 9% of its moisture by the pressure of its own weight, whereas if the garbage is mixed with other refuse the moisture will be taken up with the latter and will have to be evaporated, thus reducing the amount of heat available for power.

Mr. Hering assumes that for treating 150 tons of garbage per day by reduction, a plant with a maximum capacity of 200 tons would be required. This, he figures, would cost $225,000 to construct and would yield a revenue of 33 cts. per ton, not including the cost of delivering garbage at the plant. Supplementary to the reduction plant, he would provide a burning plant with a capacity of 100 tons per day for the disposal of rubbish (not including ashes). The estimates of the first costs and the operating costs of these two plants, slightly rearranged from the report, are as follows:

First Costs:		
Incinerator	$75,000	
Power plant	14,000	
		$89,000
Add cost of reduction plant		225,000
		$314,000
Daily cost [310 days]:		
Interest and depreciation on incinerating plant, 10%	$28.71	
Incinerating 100 tons at 45 cts.	45.00	
Operating power plant	14.52	
	$88.23	
Delivering 150 tons garbage to reduction plant, at 70 cts. per ton	105.00	
		$193.23
Daily revenue [310 days]:		
200 KW.-hr. at 1 ct.	$48.00	
10 tons ashes at 25 cts.	2.50	
	$50.50	
By-products from garbage reduction, 150 tons, at 33 cts.	49.60	
		99.10
Net cost, reduction and incineration per day		$94.13
Net cost, reduction and incineration per ton		$0.78

If all the refuse were burned, including garbage, ashes and rubbish, a plant with a capacity of 450 tons per day would be required. It is assumed that from this mixed refuse 1 lb. of steam per pound of refuse could be obtained during the fruit season, and 1¼ lbs. in winter. With a minimum temperature of 1,200° F., and forced draft, it is also assumed that there could be pro-

duced electric current to the amount of 1,000 KW. per hour. On this basis the first and the operating costs of an incinerator would be:

Furnaces and appurtenances, chimney, flues electric crane, etc.		$197,000
Buildings and grounds		60,000
Power plant for utilizing steam		50,000
Total		$307,000
Cost per day [310 days]:		
Operation, 450 tons, at 35 cts.	$157.50	
Cleaning and repairs, 5%	22.50	
Engineer, assistant and electrician	20.00	
Interest and depreciation, 10% for 310 days	99.03	
		$299.03
Revenue per day [310 days]:		
1,000 KW.-hr., at 1 ct.	$240.00	
50 tons of clinker, at 25 cts.	12.50	
		252.50
Net cost per day		$46.53
Net cost per ton		$0.10

An alternative estimate for a 300-ton plant, from which ashes would be omitted, gave a total first cost of $200,000; daily operating expenses, capital charges, etc., $229.51; daily revenue, $150.50; or a net cost per day of $79.01 and a net cost per ton of 26 cts. In this estimate it is assumed that the electric current would amount to only 600 KW. per hr., net, owing to the necessity of using fuel to make up for that allowed for in the ashes under the other estimate.

THE PAINTING OF STEEL BRIDGES AND STRUCTURAL WORK.*

Mr. J. R. Sheaff.—A new bridge is a much simpler proposition for the painter than an old one, but the future of the bridge depends upon the thoroughness of the cleaning it gets at this time, as well as upon the first coat of paint which is applied. Most bridges get a coat of linseed oil or red lead at the shops. Oil is to be preferred for two reasons: (1) The oil is transparent and allows any rust or dirt which should be removed to be plainly seen; (2) The red lead coat as usually applied at the bridge works has run down and formed pools on the flange and corners and has covered up every sign of rust that may have been left on the iron and which it is so essential to remove at this time. The only way to get these light rust stains entirely out of the iron is by the sand blast. This can get as deep into the iron as the rust can, while steel brushes and scrapers get only the top of the rust and leave the real seat of the rust deep in the metal.

There has always been a prejudice against red lead on account of its liability to run unless brushed out evenly and with care. This objection can be overcome by mixing the dry red lead with boiled oil and adding about a fourth white lead and a little dryer. The white lead will serve to hold the red lead in suspension, and will help it to dry as hard as flint. After the first coat, comes the problem of getting a paint for the finishing coats which will not dry so hard. For general results, so far, carbon is far ahead of any other paint base.

The length of time which should elapse between the general paintings of a bridge seems to be a matter of location and the thoroughness of the former painting. A bridge across the Hudson River at Mechanicville, N. Y., was given one coat of red lead and two coats of white lead paint colored with chrome yellow, and at the end of nine years was in fair shape. It was gone over and the rust scales knocked off and touched up every three years. This bridge is the best example of bridge painting which the writer has ever seen. The best painted railway bridges which have come to the writer's notice are on the Oregon Short Line. These bridges get one coat of lamp-black every four years, and are bright and clean all the time. These are two examples where a long period and a short period between paintings have both proved successful.

Mr. W. S. Morgan.—The question has been brought up about the advantages and disadvantages of painting steel with shop coats. My idea is that no matter how much care is taken by the shop people, there always remains the blue scale. The only way to get this off is to let the steel stand from six to eight months after erection, then go over it thoroughly with chipping hammers and steel wire brushes, wiping it off with benzine, always allowing plenty of time for this to evaporate. From my experience I find that no matter whether the steel has been covered with paint or oil this is the only way to get an absolutely clean surface to begin painting upon, and this is about half the game in this work. We have had bridges sent to us both with and without shop coats. I have found that those sent with shop coats, although we gave them exactly the same care as those without shop coats, seldom last over four years, while those sent us clean have lasted in a great many instances seven and eight years.

On the first coatings I have had better results from red lead than any other pigment, it being the firmest of all paints although it is necessary to watch the painters pretty closely to see that they brush it out thoroughly. There is now a combination graphite and red lead paint for first coatings. This ought to be a good thing, as it would be easier to work than the red lead and would probably have a closer bond for the second coat, provided you use graphite for the second coat. There are a great many kinds of graphite on the market and I have found a great deal of difference between their wearing qualities.

Mr. H. R. Clapham.*—The great trouble today is to get a paint that will keep down rust and scale. The Louisville & Nashville Ry. has willingly tried various paints that have been suggested. With every brand it has been the same old story of rust and scale. I think the great mistake lies in the fact that when contracts are made for structural or bridge work, they call for one coat of paint in the field before delivery. In mixing their paints, whatever may be specified, the contractors will mix an equal amount of "turps" or "benzine" with the specified amount of oil. This is then mixed and applied by piece work by incompetent workmen. There is little or no cleaning and scraping, but the paint is simply slushed on, no matter how, so that work can be got out of the yard. The result to the railway company and the master painter is that their troubles begin as soon as the work is erected.

I have come to the conclusion that when we can get those who make the contracts to cut out the clause, "One coat in field before delivery," and let us have the iron without any paint at all, we shall have no more worry and trouble. As to the adding of turps and benzine, I am pretty sure this is done in all these iron works. Where the contracts call for red lead, a new substitute is used, as I have been informed. It is called rose mineral; it is without body, and has no life to speak of. For weight, stone dust is added, and rosin oil to keep from settling. I have had frequent fault finding from our engineer headquarters about the condition of the work after the paint has been applied. It is worse the nearer we get to the southern coast, owing to the salt air.

*Abstracts of papers read at the annual meeting of the Maintenance-of-Way Painters' Association at Chicago, in November.

†Master Painter, Pacific Electric Railway Co., Los Angeles, Cal.

*Master Painter, Louisville & Nashville Ry., Louisville, Ky.

DOUBLE-TRACK TRUNNION BASCULE BRIDGE OVER BODINE CREEK, STATEN ISLAND RAPID TRANSIT RAILWAY.

A counterweighted bascule bridge of the Strauss pattern, with overhead counterweight, has recently been built over Bodine Creek, at Port Richmond, Staten Island, New York City. Two views of this structure are reproduced herewith (Figs. 1 and 2). It is a small bridge, spanning a 40-ft. clear channel, the main girders being about 60 ft. long. It is interesting, however, because of its simplicity of arrangement, and because of the unusual disposition of supports under the three main girders. In lifting, the bridge is a two-girder structure, since trunnions are provided for the outside girders only; but when the bridge is closed, all three girders carry load, and in fact the middle girder, by virtue of its position, carries half the total live-load. Wedge supports are arranged under the girders at the forward end of the trunnion pier which relieve the trunnions of most of the load when the bridge is closed.

FIG. 1. BRIDGE PARTLY OPENED.

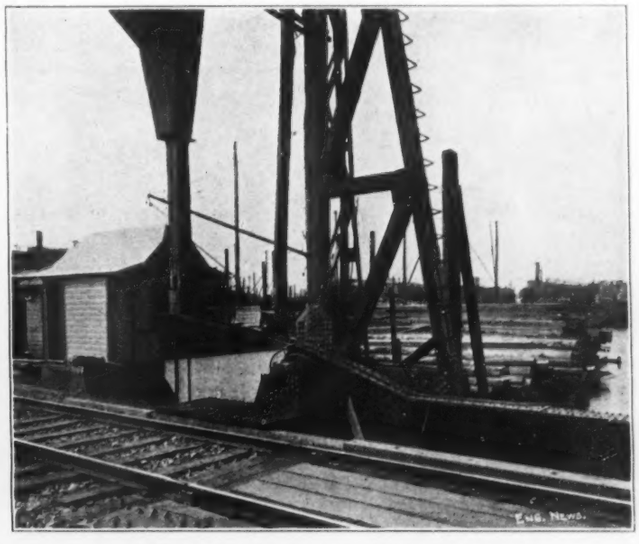


FIG. 2. VIEW ON DECK, SHOWING TRUNNION.

FIGS. 1 AND 2. DOUBLE-TRACK TRUNNION BASCULE BRIDGE OVER BODINE CREEK, PORT RICHMOND, STATEN ISLAND.

The Strauss type of counterweighted bascule was described in general terms in our issue of Nov. 24, 1904, p. 480, where outline drawings were shown of a design with overhead counterweight and a design with underfloor counterweight. Bridges of the overhead counterweight type have since been constructed at Cleveland, O., and Rahway, N. J. The essential feature of the design is direct balancing by a counterweight concentrated at the extreme end of the tail of the bridge and so guided by links as to keep the center of gravity of the moving system in constant relation to the bridge. Complete balancing of a trunnion bascule bridge is often attained by attaching the counterweights directly to the tail of the bridge. But as the counterweights necessarily occupy a considerable space, their effective radius of action is only a fraction of the length of the tail of the bridge; or, in other terms, for a given weight of counterbalance a much longer tail is required than if the whole counterweight could be concentrated at the extreme end. It is, of course, very desirable to reduce the length of tail as much

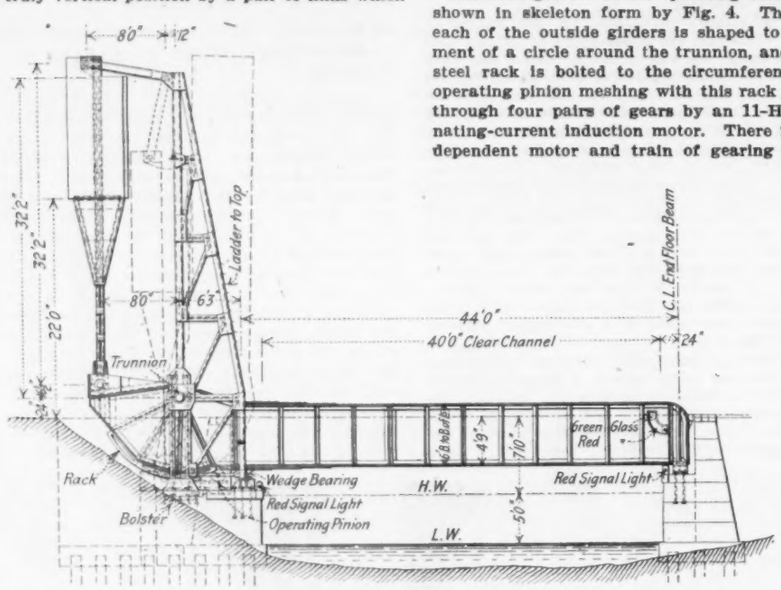
as possible, because the clear space below, the tailpit, which is necessary to receive the tail as the bridge rises, adds considerably to the cost of the substructure and usually must be kept dry by pumping when the bridge has a low elevation above water.

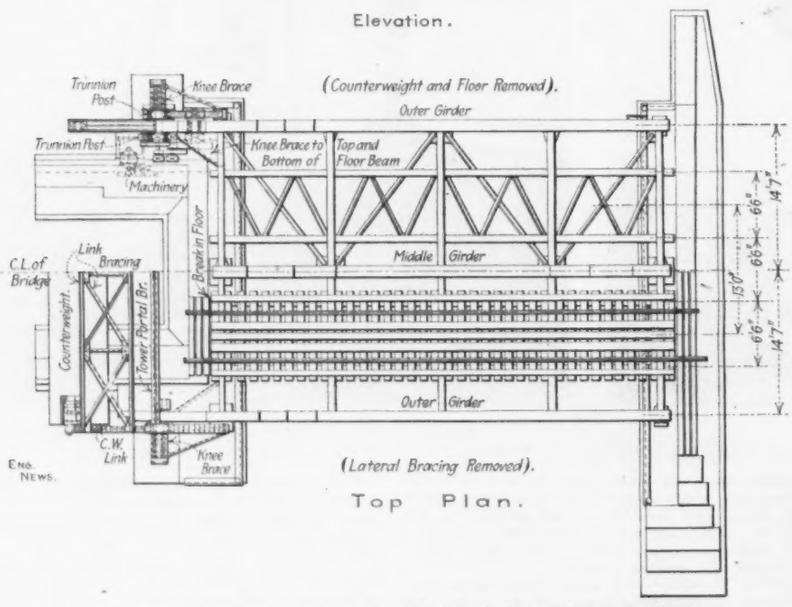
In the Bodine Creek bridge, shown quite fully by the general drawing Fig. 3, the counterweight is carried above the clearance height of the railway line, on two vertical posts, each of which bears on a pin fixed in the end of the tail of the corresponding outer girder. These posts are held in truly vertical position by a pair of links which connect the upper end of the counterweight with the top of a light steel tower erected over the trunnions of the bridge. The links are parallel to the line joining the trunnion center and the counterweight-pin center, and their length is equal to the length of this line. The links and posts therefore constitute a parallel motion which maintains the counterweight at all times vertically over the tail-pins and therefore ensures constancy of the counterweighting action. This in turn gives constancy of counterbalancing provided the center of gravity of the moving leaf (excluding counterweight) lies in the same straight line as the trunnion center and the tail-pin center, which condition is readily satisfied by carefully calculating the necessary location of the tail-pin. The amount of counterweight does not affect the constancy of condition, and may evidently be adjusted to give either a residual closing tendency or a resultant opening tendency or perfect counterbalance, as may be desired. We understand that in the case of the bridge illustrated the counterweight was proportioned to give complete counterbalance, as nearly as may be, so that the bridge is in equilibrium in any position independently of the action of motor and brakes.

The arrangement of the operating machinery is shown in skeleton form by Fig. 4. The tail of each of the outside girders is shaped to the segment of a circle around the trunnion, and a cast-steel rack is bolted to the circumference. The operating pinion meshing with this rack is driven through four pairs of gears by an 11-HP. alternating-current induction motor. There is an independent motor and train of gearing for each outside girder. The pinion and rack have shrouded teeth of 3½-in. pitch, and the pinion is 10½ ins. wide between shrouds. The pinion shaft is 6½ ins. in diameter. Each motor is fitted with a solenoid brake.

The lock at the free end of the bridge is driven by a 6-HP. alternating-current motor which also sets the wedges under the girders at the forward end of the trunnion pier. The arrangement of this drive is clearly shown by Fig. 4. The lock pin comes to upward bearing against a lug bracketed out from the abutment. Since the bridge is balanced about the trunnions for dead load, the driving of the wedges produces an uplift at the free end, which must be resisted by the latch. The drive shaft contains a slip coupling so arranged that the latch is closed before the wedges are driven, and is released only after the wedges are withdrawn. When the wedges are driven to full bearing, the motor is cut out by a switch actuated through an electric contact made by the motion of the wedge lever.

The trunnion is a steel shaft 9½ ins. in diameter in the girder collars and 7¾ ins. in the bearings in the trunnion posts. The collars are cast-steel, each 5¹³/₁₆ ins. long, one being bolted to either side of the girder by 20 1-in. turned bolts. Each trunnion bearing is of cast-steel, 12½ ins. long,





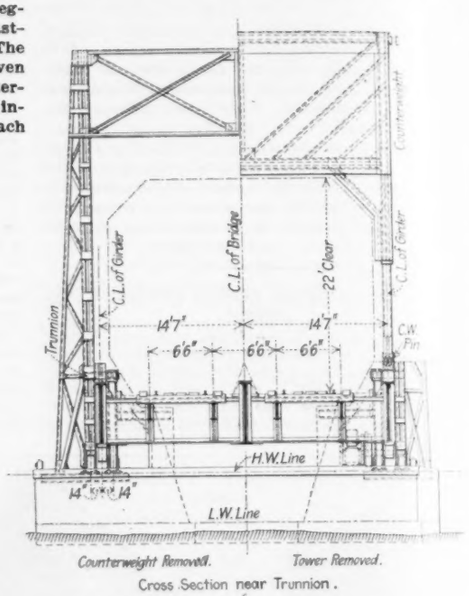


FIG. 3. GENERAL PLANS OF BODINE CREEK BASCULE BRIDGE.

seated on a short riveted steel post which foots on the pier masonry, one on either side of the girder. The lower half of the bearing contains a phosphor-bronze bushing, held down by the cast-iron cap. Both the bushing and the cap have crossed grooves for grease lubrication, supplied by two grease-cups on the cap. The trunnion shaft has a bending stress of 17,000 lbs. per sq. in. and shear of 2,500 lbs. per sq. in. under dead-load. No live-load is intended to come on this bearing, being carried by the wedge supports. The dead-load bearing pressure of the trunnion is 1,400 lbs. per sq. in. of horizontal projection.

The tail-pin is a steel casting turned to 13½ ins. diameter, 11¾ ins. long, bolted between side plates built up from the top flange of the girder tail. The counterweight post has a cast-steel shoe bolted to its lower end, which contains a phosphor-bronze bushing that bears on the pin. Two grease cups in the shoe feed grease between the bushing and the pin, and the cast-iron cap bolted to the shoe below the pin is cored out to retain the grease.

In its structural arrangement, the bridge follows conventional types of design. The three main girders are plate-girders 72 ins. deep back to back of angles. The two outer girders are prolonged over the abutment for the trunnion and counterweight attachment, while the middle girder stops at the end floorbeam at the trunnion-pier end. When the bridge is closed, all three girders at this end rest on the wedges shown in Fig. 4, but when the bridge is raised off its bearings the middle girder is carried by the floorbeams. The rear floorbeam is on this account stiffened by diagonal brackets extending from the outer stringer backward and upward to the main girder, as may be seen in the view Fig. 2. The counterweight framing is simple, as shown by Fig. 3. The outer trunnion-post is extended upward to form the main post of the guide tower, and two inclined brace legs hold this post in place. The counterweight itself is a concrete block built around a steel framework. In addition to the

overhead counterweight, a considerable amount of counterweight is provided by filling the tail of each outside girder with concrete built out flush with the flanges.

The rail joints at both ends of the bridge are mitered, and as they lift clear of each other they have no locks.

The substructure of the bridge is of concrete, founded on piles. The trunnion pier is shaped in such a way as to give space for the tails of the outside girders and the lift gearing outside of the lifting walls, the face wall being extended beyond these at a lower level, as shown by Fig. 3.

This bridge replaces a pair of single-track jack-knife draws operated by hand. In its construction the draws were placed out of service alternately, the piers being first built in successive halves, and then the superstructure erected in the same order, in the closed position; the creek of course was closed during the erection of the superstructure. The new bridge was put into service Sept. 15, 1907. Its maximum time of operation is 1½ mins. It was built by the Strauss Bascule & Concrete Bridge Co., Fort Dearborn Bldg., Chicago, under the direction of the engineering department of the Staten Island Rapid Transit Co., the owners of the bridge.

A SPRING-MOTOR PUMPING DEVICE was advertised by a Kansas concern as able to supply water enough for a stock farm and that 15 minutes' winding by an 18-year-old boy would make the motor run for 12 hours. County rights for the use of the invention were sold at $100 to $200 per county and it is said that some $60,000 had been secured in this way when the promoters were arrested for using the mails with intent to defraud. In the trial it was shown by expert testimony, that to store the amount of power which the company claimed for its motor would require springs weighing 100 to 200 tons.

CELLULOSE ACETATE AS WIRE INSULATION.*

By R. FLEMING,† Assoc. Am. Inst. E. E.

Insulated copper wire is such a ruling factor in the design and manufacture of electrical apparatus, that any process which reduces either the cost of the insulated wire is of great commercial importance.

Silk and cotton are about the only materials which have been used in the past for insulating purposes. The former is relatively expensive, while the latter, though cheap, occupies an unfortunately large proportion of the winding space, especially when the wire itself is small. Various chemical solutions have been applied to wires in the attempt to secure a thin, though permanent insulation, which would be more economical to use than silk or cotton. Cellulose acetate, enamel, collodion, casein, albumen, glue, rubber, silk solutions, etc., were tried with more or less favorable results, but for commercial purposes cellulose acetate and enamel have proven to be the substances best adapted to the insulation of copper wires.

The mechanical properties of the cellulose acetate film make it a desirable insulating medium for very fine wires. Its elasticity permits of considerable stretching of the wire before rupture takes place, thus insuring continuous insulation between wires on the finished coil. Its specific resistance is very high, so that the film even though thin, provides ample insulation between turns and between the layers of superposed wire. The evenness of the coating, and the regularity with which the film can be applied to the wire, are important advantages; the finished wire is free from imperfections of coating, and presents an attractive appearance. This insulation can be colored any desired shade to harmonize with the surroundings. In case of very fine wire, a bright green makes a satisfactory color, rendering it easy for the operators to see the wire, and to detect irregularity in the winding; but if these fine wires are colored a neutral tint, they are practically invisible, and winding them is a difficult operation.

The sizes of wire best suited to this process are from 0.003 in. in diameter, or even finer, to those as large as 0.005 in. These diameters correspond to about 40 and 35 B. & S. gage. For larger sizes, the enamel coatings are more suitable.

Cellulose acetate has been used for a number of years for the windings of meter armatures, where light weight is of great importance. Table I. shows some of the more important comparisons of data:

TABLE I.—COMPARISON OF CELLULOSE ACETATE, SILK AND COTTON INSULATION.

.003 Diam. of Copper	Acetate	Single silk	Single cotton
Thickness of insulating film	.0005	.0009	.00175
Wire space factor	.442	.313	.167
Wt. per thousand feet (lbs.)	.033	.036	.049

With acetate coated wire the greatly improved space factor means, that for a given number of turns on a given form, the mean length of turn and total weight of wire is greatly reduced. This is shown in Table II, which is drawn up on the basis of a perfect winding:

TABLE II.—COMPARISON OF COILS WOUND WITH WIRES INSULATED WITH CELLULOSE ACETATE, SILK AND COTTON.

Diameter of spool....1 in. Number of turns.. 100,000
Length of spool.....1 in. Diameter of copper .003 in.

Insulation of Conductor	Outside Diam. of Coil (Inches)	Resistance (Ohms)	Wt. of Coil (Lbs.)	Price per pound to give same cost of coil
Acetate	4.50	71,500	2.22	$7.50
Single silk	5.53	80,500	3.04	5.50
Single cotton	9.50	144,000	6.73	2.50

The great decrease in size shown would, in itself, often be enough to warrant the use of acetate wire.

Another great advantage of acetate wire is that it is not affected by ordinary atmospheric conditions. Complete drying and impregnating processes are necessary for fibrous insulations, if long life is to be expected of them. Manufacturers of telephones and other specialties, who use fine wires, will find film-coated wires of very great service in reducing the cost, and also the size, of their apparatus.

In the Lynn acetate wire-coating machines the solution automatically passes from the mixing reservoirs to the coating portion of the apparatus. Here, by a system of transfer wheels, the solution is applied to the revolving coating roll, which, in turn, deposits it on the moving wire. The quantity of solution placed on the wire must be adjusted to a nicety; therefore mechanical scrapers are employed, which remove the excess and leave just the proper amount to be deposited.

After receiving its coating of solution, the wire passes through the oven at the rate of several hundred feet per minute. The volatile solvent is here driven off and the coating hardened, after which the process is repeated until numerous coatings have been applied. This method insures an even distribution of the film over the whole surface of the wire. To keep the fine wire moving at such a high rate of speed, a very delicate adjustment of the moving parts is required, for the slightest unevenness of motion is sure to break the wire. This is prevented by friction drives and friction tension devices, which insure a uniform motion.

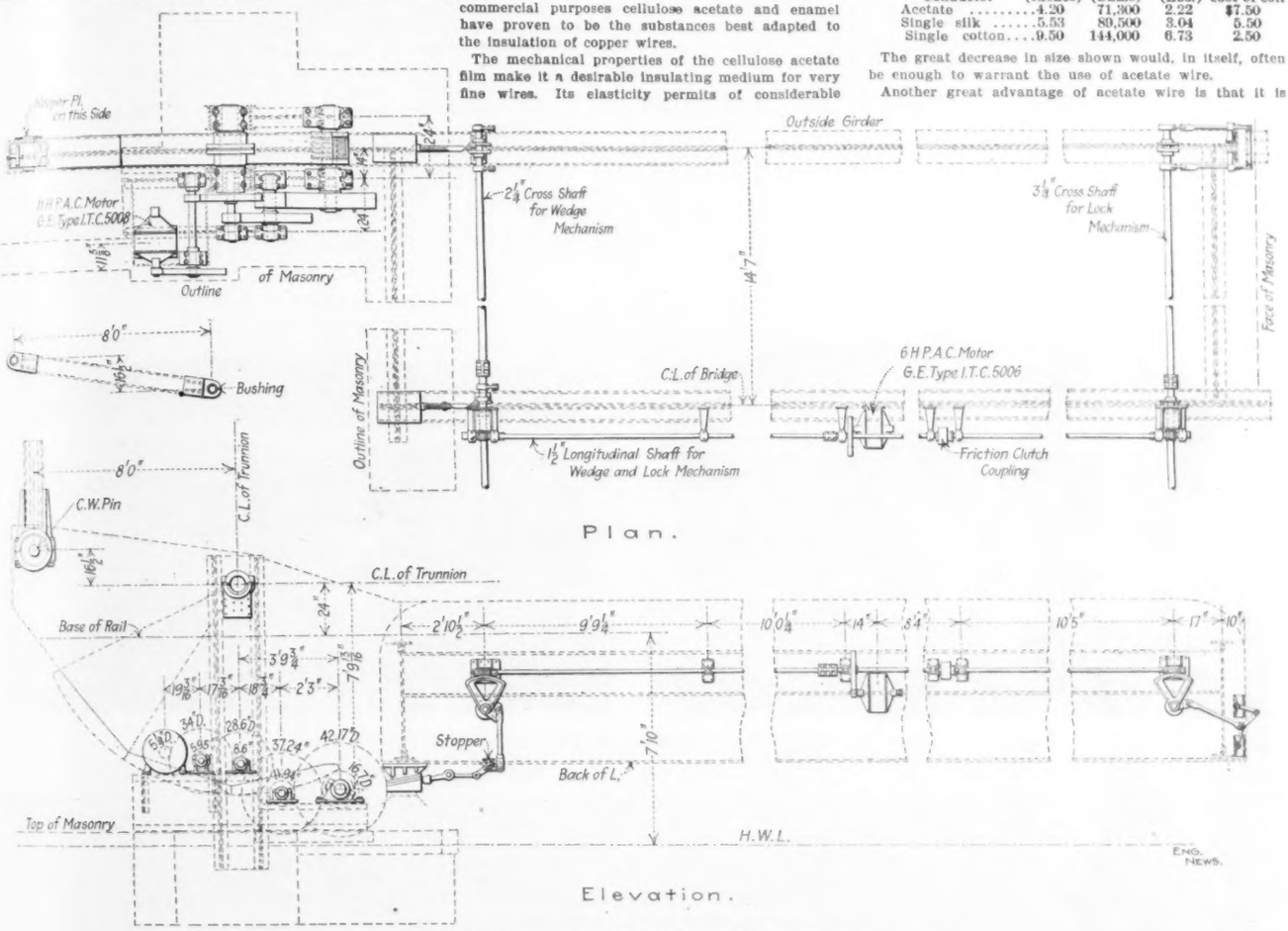


FIG. 4. ARRANGEMENT OF OPERATING MACHINERY.

*Extracts from an article in the "General Electric Review," Jan., 1908.

†Engineer, General Electric Co., Lynn, Mass.

TWELVE TESTS OF CARBON-STEEL AND NICKEL-STEEL COLUMNS.

By J. A. L. WADDELL,* M. Am. Soc. C. E.

I have been deeply interested in reading Mr. C. P. Buchanan's valuable paper on "A Series of Failure Tests of Full-Size Compression Members," in Engineering News of Dec. 26, 1907, and the editorial discussing these tests.

I have recently been making some similar tests of full-size compression members in connection with an investigation as to the value of nickel-steel for bridges. I engaged the Osborn Engineering Co. to make all the necessary experiments; and the work was carried out by Mr. George C. Saunders under my immediate direction. The entire investigation was very complete, and the records are voluminous, I expect to publish them shortly; but the data relating to the column tests are sufficiently independent for detached presentation here.

The tests were made primarily to determine the relative strengths of nickel-steel and carbon-steel; consequently, three long columns and three short columns constructed of each metal were tested. As shown on the accompanying photographs Figs. 1 to 4, all the columns were pin-ended. They were composed of two built channels, each consisting of two 3 × 3 × ⅜-in. angles and one 12 × ⅜-in. plate, connected at the ends by batten plates and laced with 2½ × ⅜-in. bars.

The numerical results of the tests are given in Tables I-IV below.

The determination of the elastic limit for these columns proved to be a very difficult matter in spite of the fact that the best possible apparatus was used and the greatest care employed by Mr. Saunders. I am convinced that he erred upon the side of safety in making his determinations, for an inspection of his records shows that had he employed the customary or commercial method for finding the elastic limit, the results would have been somewhat higher; hence in dealing with the preceding tabulations one need not fear that erroneously great values of elastic limit were recorded. All the experiments from which this group of column tests is selected were primarily comparative, nickel-steel being contrasted with carbon-steel in every practicable kind of test, yet the results may satisfactorily be compared with those recorded by Mr. Buchanan, because his sections did not differ materially from mine and most of his struts had one or both sides latticed.

Throwing out of consideration all of the wrought-iron columns tested by Mr. Buchanan, there remain seven steel columns, from which the following averages have been computed:

Carbon-Steel Columns, Buchanan's Tests—
Length-ratio 60.4
Elastic limit ..... 20,957 lbs. per sq. in.
Ultimate strength ..... 31,887 lbs. per sq. in.

The corresponding averages of my six tests of carbon-steel columns give:

Carbon-Steel Columns, Waddell's Tests—
Length-ratio 54
Elastic limit ..... 25,800 lbs. per sq. in.
Ultimate strength ..... 34,870 lbs. per sq. in.

To make these averages more comparable, my figures should be reduced for the greater value of l/r; and the best way that I know of for doing this is to take from Table V of "De Pontibus" the intensities of working stresses for columns with pin ends for $l/r = 60.4$ and 54, and their ratio, and use it as a reduction factor.

$$\left.\begin{aligned} \text{For } \frac{l}{r} = 60,\ I = 11{,}200 \\ \text{For } \frac{l}{r} = 61,\ I = 11{,}120 \end{aligned}\right\} \therefore \text{ for } \frac{l}{r} = 60.4,\ I = 11{,}168$$

$$\text{For } \frac{l}{r} = 54,\ I = 11{,}680$$

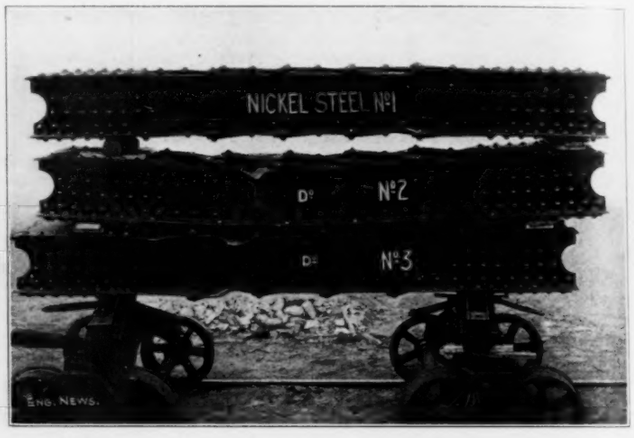
$$\therefore r = \frac{11{,}168}{11{,}680} = 0.956.$$

Consequently, my comparative figures are:

Carbon-Steel Columns, Waddell's Tests, Reduced—
Length-ratio 60.4
Elastic limit ..... 24,665 lbs. per sq. in.
Ultimate strength ..... 33,336 lbs. per sq. in.

From this it can be seen that my results are better than those found by Mr. Buchanan by the ratio of 24,665 ÷ 20,957 (= 1.18) for elastic limit and of 33,317 ÷ 31,887 (= 1.05) for the ultimate strength. For this there might be several causes, viz., first, a variation in the strength of the metal; second, a difference in the method of determining elastic limits; and, third, superiority of detailing.

Unfortunately, only five of Mr. Buchanan's records for steel struts give the ultimate strength and only one the elastic limit found by the speci-



FIGS. 1 AND 2. SHORT TEST COLUMNS; CARBON STEEL AND NICKEL STEEL.

Length, 10 ft. c. to c. of pins; Section, four 3 × 3 × ⅜-in. angles, two 12 × ⅜-in. plates, lattice 2½ × ⅜-in. top and bottom; Section 17.44 sq. ins. Least radius of gyration 4.46; l/r = 27.

The webs were heavily reinforced for bearing and for the transmission of the stress from the pin to the column section in order to ensure that the failure of the columns would be in the body and not in the details. The lengths between centers of pins were 10 ft. for the short struts and 30 ft. for the long ones; and the radius of gyration was 4.46 ins., making the values of l/r respectively 27 and 81. The area of the section was 17.44 sq. ins.

The carbon-steel struts were built of railway bridge steel which complied substantially with the specifications of "De Pontibus," i. e., steel having an ultimate strength between 60,000 lbs. and 70,000 lbs. per sq. in. and an elastic limit of not less than 35,000 lbs. per sq. in. The nickel-steel used was obtained from special melts, and had an ultimate strength between 100,000 lbs. and 115,000 lbs. per sq. in. and an elastic limit not less than 60,000 lbs. per sq. in. The nickel-steel contained approximately the following percentages of materials:

	Per cent.
Nickel	3.50
Carbon	0.38
Manganese	0.75
Sulphur	0.30
Phosphorus	0.015
Silicon	0.05

The material was rolled by the Carnegie Steel Co. at its Homestead Works, and was fabricated in the American Bridge Co.'s shops at Ambridge, Pa. The tests were made on the 2,160,000-lb. hydraulic testing machine of the Phoenix Iron Co., at Phoenixville, Pa.

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RESULTS OF FAILURE TESTS OF FULL-SIZE COLUMNS; CARBON-STEEL AND NICKEL-STEEL.

TABLE I.—SHORT NICKEL-STEEL COLUMNS.

A = 17.44 sq. ins.; l = 120 ins.; r = 4.46 ins.; l/r = 27.

Strut No.	Elastic limit.	Ultimate strength.
1	53,700	68,500
2	.....	68,500
3	51,800	69,200
Average	52,800	68,700

TABLE II.—SHORT CARBON-STEEL COLUMNS.

A = 17.44 sq. ins.; l = 120 ins.; r = 4.46 ins.; l/r = 27.

Strut No.	Elastic limit.	Ultimate strength.
1	29,600	38,900
2	29,600	39,800
3	27,200	38,900
Average	28,800	39,200

TABLE III.—LONG NICKEL-STEEL COLUMNS.

A = 17.44 sq. ins.; l = 360 ins.; r = 4.46 ins.; l/r = 81.

Strut No.	Elastic limit.	Ultimate strength.
1	39,800	44,400
2	42,500	47,200
3	.....	42,500
Average	41,200	44,700

TABLE IV.—LONG CARBON-STEEL COLUMNS.

A = 17.44 sq. ins.; l = 360 ins.; r = 4.46 ins.; l/r = 81.

Strut No.	Elastic limit.	Ultimate strength.
1	.....	29,600
2	22,200	32,400
3	20,400	29,600
Average	21,300	30,500

men tests; and in my case there were no special tests made for the strength of the carbon-steel employed, as some metal left over from bridge work built under modern standard specifications was used. All that the inspector had to do was to see that the metal complied with the requirements of the "De Pontibus" specifications, for which the average ultimate is 65,000 lbs. and the least allowable elastic limit is 35,000 lbs. Mr. Buchanan's records give an average ultimate of 64,000 lbs. and a single elastic limit of 39,000 lbs. As the bridge metal of commerce is about 2,000 lbs. weaker than the average for the "De Pontibus" specifications, and as the average elastic limit (as determined by the drop of the beam) for metal purchased thereunder generally exceeds the allowable minimum by 4,000-5,000 lbs., it is evident that in all probability there was no important difference in the strength of Mr. Buchanan's steel and mine.

As before stated, Mr. Saunders' method of determining elastic limit was conservative, for he invariably obtained throughout the entire series of tests lower elastic limits than other experimenters who had tested the same metal; consequently the superiority under consideration is not likely to be due to ultra-high records of elastic limits in our column tests as compared with those of Mr. Buchanan.

There remains, therefore, only the question of character of detailing. My instructions to our chief draftsman in preparing the drawings for the test columns were to make the struts so strong in every detail that they would have to

fail in the main portions; and the photographs of the broken columns show that these instructions were followed. A study of the photographs submitted by Mr. Buchanan shows that at first the detailing at ends of struts was very defective, but that later it was improved, although not perfected. The steel columns in the series of tests by Mr. Buchanan are Nos. III, IV, IX, XVI, XVII, XVIII and XIX.

Column III appears from the rather incomplete drawing to be pretty well detailed, although the experiments showed failure in the rivets attaching the pin-plates to the Z-bars. This failure undoubtedly decreased somewhat the strength of the column, as did also the double counterweight attached at the middle.

Column IV was similar to Column III, but the counterweight was properly adjusted, hence there ought to be an increase in the recorded strength. There is such in the elastic limit; but unfortunately there is a decrease in the ultimate. The failure in this case also of the connecting rivets shows that the detailing was imperfect, and yet, if the rivets were ¾-in. in diameter, there were just enough of them used for the connection.

But even if the detailing in these struts was imperfect, the columns showed high elastic limits, averaging 24,150 lbs. per sq. in. Table V of "De Pontibus" gives for $l/r = 83$, an intensity of 9,360 lbs. per sq. in., which is only 39% of that elastic limit. This is well within the requirements of good practice.

Column IX should not really be considered, because it was not straight either as a whole or in part. Moreover, its section was not a good one for struts, although it is commonly so used in small riveted bridges, and is all right if l/r is kept low and if the designer is liberal in providing extra section for rigidity. I should not think of using this style of column with such a high value of l/r as 97. The effect of the imperfections is shown in the low elastic limit rather than in the ultimate strength. For a static load my formula would permit such a column to be loaded to 8,240 lbs. per sq. in.; and this would be all right for a properly manufactured column of the kind.

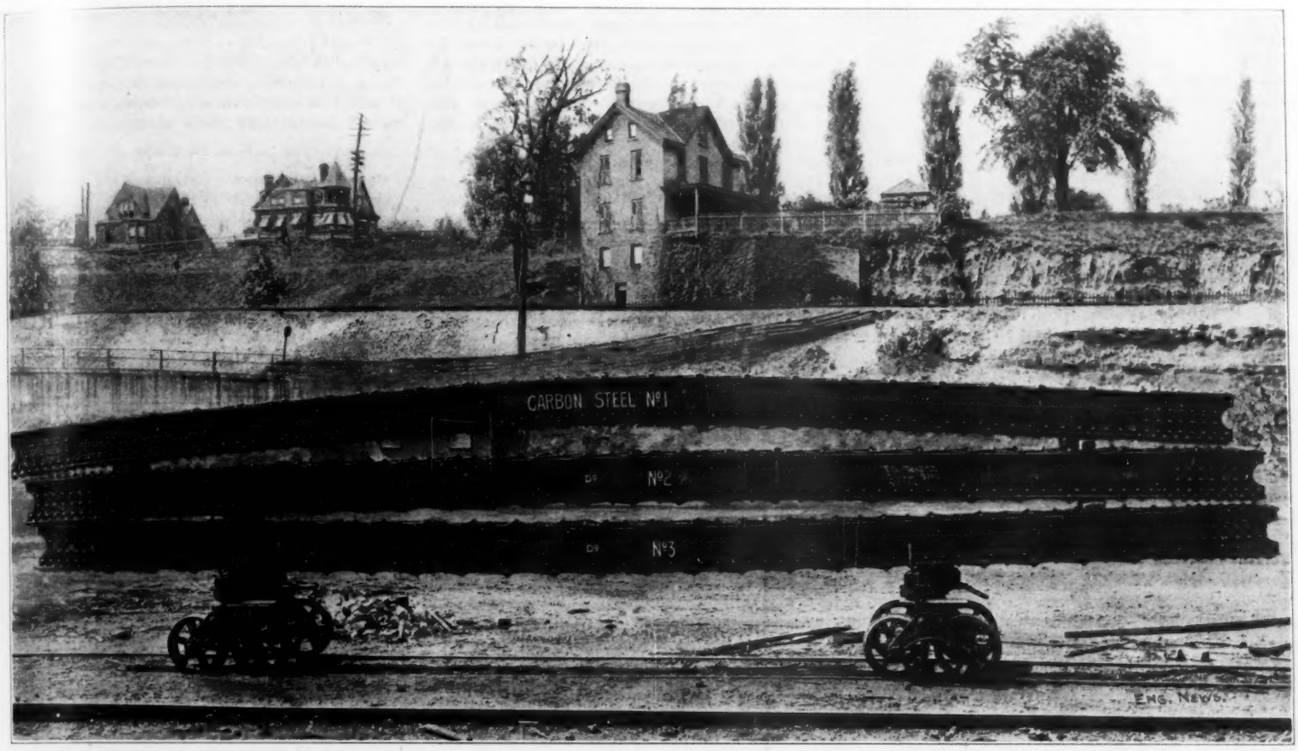
Column XVI appears to have been sufficiently well detailed, and the variation of pin-center from neutral axis was very slight. This is a top-chord section, hence I would use Table IV of "De Pontibus," which gives for $l/r = 46$ an intensity of 14,780 lbs., which is somewhat more than one-half of the recorded elastic limit of 25,500 lbs. per sq. in. However, the test was not a fair one for a chord section, because in a bridge the ends of the chord sections would be fixed, and most of the stress would be applied uniformly over the whole section and not through the pin. In order to test properly a chord section the ends should be fixed by enlargement and the pressure should be applied as nearly uniformly as practicable over the enlarged ends. Using Table V, which is for hinged ends, the intensity would be 12,320 lbs., which is less than one-half the elastic limit.

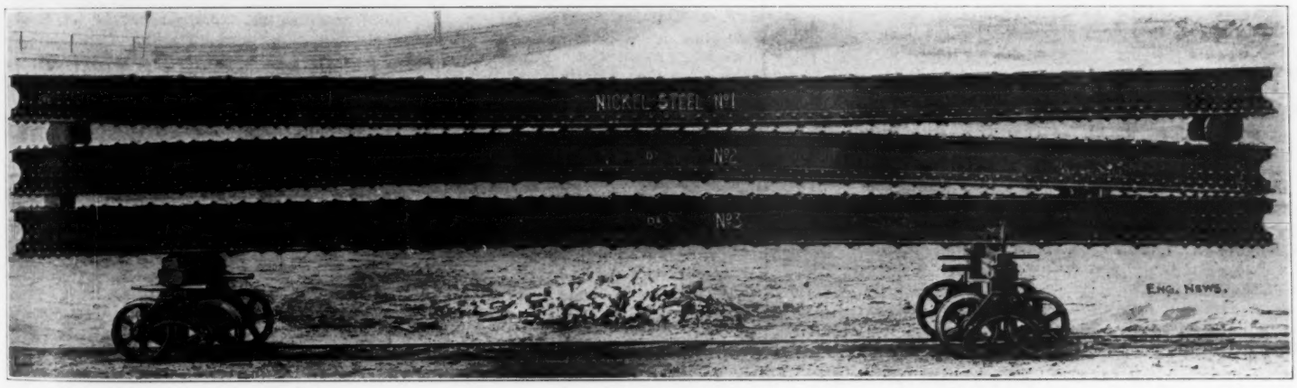
Column XVII was not in perfect alinement when it came from the shops, hence the test is not reliable. The effect of the imperfection is shown in the low elastic limit of 19,000 lbs. per sq. in., which is too small in comparison with the ultimate strength of 31,680 lbs.

Column XVIII appears to have been well detailed, and it broke near the middle, the elastic limit being 22,600 lbs. and the ultimate strength 31,980 lbs. per sq. in. Applying the formula for hinged ends, makes the allowed intensity 13,280, which is too great for the recorded elastic limit.

Column XIX, which is practically a duplicate of Column XVIII, must have had some defect that caused it to fail in the peculiar way it did and to indicate an elastic limit so much lower than its mate.

Referring now to my own tests of carbon-steel columns: for l/r=27, the allowed intensity of load-





FIGS. 3 AND 4. LONG TEST COLUMNS, CARBON STEEL AND NICKEL STEEL.
Length, 30 ft. c. to c. of pins; Section, same as for Short Columns; $l/r = 81$.

ing from "De Pontibus," Table V, is 13,840 lbs., which is not only less than one-half of the average elastic limit of the three tests, but also is less than one-half of the lowest elastic limit recorded. In the case of $l/r = 81$, the intensity is 9,520 lbs., which is below one-half of either of the two elastic limits recorded.

For nickel-steel columns having both ends hinged I have established the formula for allowed loading:

$$I = 27{,}000 - 160\ l/r,$$

which for $l/r = 27$ gives an intensity of 22,680, and for $l/r = 81$ an intensity of 14,040. Comparing these with the recorded averages of 52,800 and 41,200 shows that I am well on the side of safety in the formula under consideration.

In view of the results of my tests on columns I am unable to agree with the conclusions expressed editorially in Engineering News of Dec. 26 upon the inadequacy of column formulas used in bridge designing; for I believe that if the equivalent static load is less than one-half of the elastic limit, perfect safety is attained. The addition of 30% to the working intensities to meet the condition of a combination of the greatest equivalent static load and the maximum wind load is more in the nature of a salve to the designer's conscience than an attempt to meet actual conditions; because a simultaneous application of the greatest live-load, greatest impact, and greatest wind pressure is almost an impossibility; and in view of this, if it ever did happen, the straining for an instant of a few members to 65% of their elastic limits would do no harm.

As far as carbon-steel struts with hinged ends are concerned, my experiments show that my formula, $I = 16{,}000 - 80\ l/r$, is perfectly safe. Unfortunately, I have as yet had no means of testing my other formulas, which are:

For top chords: $I = 18{,}000 - 70\ l/r$.

For inclined end posts: $I = 18{,}000 - 80\ l/r$.

For web struts with fixed ends: $I = 16{,}000 - 60\ l/r$.

It is generally agreed that struts with fixed ends have greater strength than those with hinged ends, consequently it is not likely that the untested formulas are any weaker than the tested one, which I am confident is all right.

As my practice does not differ essentially from that of other American bridge engineers of recognized standing, I believe that no great mistake in regard to the dimensioning of steel columns has been commonly made by the engineering profession. Some engineers (mostly, however, those engaged in contracting) have made the mistake of assuming that for comparatively small values of l over r there is no loss of strength in a column as compared with a short block; and I see that the Editor, too, had this idea in mind when, near the beginning of p. 703, he said "even though the series included columns so short that the 'column reduction' effect is virtually eliminated." In Mr. Buchanan's series of tests there was only one case of l/r less than 30; there were two between 30 and 35, and five between 35 and 40; consequently I assume that the Editor would probably place the limit of effect of column reduction at about 35.

It is my belief that each unit increment of l/r from zero upward lessens the column strength, although some bridge designers do not reduce the working intensity for any value less than fifty. Referring to my hinged-end formula, for $l/r = 50$ the intensity is 12,000 lbs. instead of 16,000 lbs. per sq. in. for a short block, showing a reduction of 25%.

The establishment of intensities of working stresses from the elastic limit instead of from the ultimate strength is correct, and especially so in struts, even though the elastic limit and the ultimate come pretty close together; for there is no analogy between the action of a column strained not to exceed one-half the elastic limit and one strained to exceed the elastic limit. In the former the lateral deflection is extremely small and therefore the stress is mainly that due to direct load, while in the latter it is great and therefore the principal stress is that due to bending.

I cannot agree with the editorial assertion that

> the crippling strength of a compressive member—the point where its final failure occurs, may be even lower than the yield point of the material. We do not now refer to the reduction properly to be expected in long columns, as expressed by every column formula, but to a difference between the yield point and the base constant which serves as the initial point of the column formula.

I believe on the contrary that when struts are properly designed and properly manufactured, and when due account is taken of the weakening effect of l/r, the crippling strength will never fall below the elastic limit or yield-point of the material, especially when the latter point is scientifically instead of commercially determined.*

In confirmation of my conviction concerning the crippling strength not falling below the elastic limit, let us examine the results of my twelve column tests.

Table I shows the average ultimate strength, or the crippling load, for three short nickel-steel columns to be 68,700 lbs. and a minimum of 68,000 lbs., the elastic limit for specimen tests being 60,000 lbs. minimum, or probably two or three thousand pounds higher actually.

Table II shows the average ultimate strength for three short carbon-steel columns to be 39,200 lbs. and a minimum of 38,900 lbs., the elastic limit being 35,000 lbs. minimum, or probably some two thousand pounds higher actually.

These results are for $l/r = 27$, and they are a direct contradiction to your above-quoted conclusion.

Table III shows the average ultimate strength for three long nickel-steel columns to be 44,700 lbs. and a minimum of 42,500 lbs. for a minimum elastic limit in tension of 60,000 lbs. as found by specimen tests. In this case the value of l/r is 87, for which my column formula

$$I = 27{,}000 - 160\ l/r$$

reduces the working intensity as compared with that for a short block 48%. Applying this reduction to the specified elastic limit for the sake of comparison makes it 31,200 lbs., which is far below the lowest crippling load.

Table IV shows the average ultimate strength for three long carbon-steel columns to be 30,500 lbs. and a minimum of 29,600 lbs. for a minimum elastic limit in specimen tests of 35,000 lbs. For $l/r =$ to 87 my formula

$$I = 16{,}000 - 80\ l/r$$

reduces the working intensity as compared with that for a short block about 43%. Applying this reduction to the specified elastic limit as before, makes it about 20,000 lbs., which is far below the lowest ultimate recorded, and even below the lowest elastic limit.

It is possible that this method of comparison for long struts may not be accepted; but there is no gainsaying my figures for the short ones.

Again, it may be objected that my series of tests does not give as good an average as those of Mr. Buchanan, as he records 19 broken columns while I record but 12. To this I would reply that my records give a truer average than his because confessedly seven of his struts were badly detailed and therefore failed to develop full strength on that account, and four were either crooked or had pin-holes too eccentric with respect to gravity lines. Subtracting these 11 defective struts from the total of 19 leaves only 8 from which true deductions may be drawn, while I have 12 properly designed and properly manufactured columns in my series.

I wish to call attention to the facts that Mr. Buchanan's Column XIV had an eccentricity of 0.47-in., and that Column XV had one of 0.14-in., also that these were included in the tests from which the deductions of Engineering News editorial were made.

*It is not generally known, but it is true, nevertheless, that in operating a testing machine one can obtain within reasonable limits as high a yield point as he may desire by simply speeding the machine. My series of comparative tests of nickel-steel and carbon-steel proved this to me conclusively. The true and scientific method of determining elastic limit is by operating the machine slowly, and this method was adopted by my instructions throughout the entire series of tests.

The following is offered as a rather crude but approximately correct mathematical analysis of the effect of eccentricity on columns:

Let P = direct load,
A = area of section,
r = radius of gyration,
d = distance from center of gravity to most remote fiber where failure occurs,
e = eccentricity,
$C = P/A$ = intensity of direct compression,
R = intensity due to bending,
M = bending moment, and
I = moment of inertia of section.

Then

$$M = Pe,$$

$$R = Md/I = Ped/I = Ped/Ar^2 = C\ ed/r^2.$$

But d is generally about one-half the total depth D and r is generally about three-eighths of the same. Substituting these gives

$$R = {}^4/_3\ C\ e/r.$$

In Mr. Buchanan's Column XIV, $e = {}^1/_{10}\ r$. Substituting this in the formula gives $R = {}^4/_3 \times {}^1/_{10} \times C = 0.133\ C$. From this it is evident that if the preceding formula is approximately correct, the actual intensity at the time the elastic limit was recorded was 1.133 times that observed, or $17{,}200 \times 1.133 = 19{,}488$ lbs. Column XIII, in which the eccentricity presumably was zero, gave an elastic limit of 20,150 lbs., and as the values of l/r in the two cases were almost identical, the check on the correctness of the mathematical investigation is quite satisfactory. It must be admitted, though, that the tabulated figures for Column XV would not give as good a check. It would require the results of a great many column tests involving eccentricity to give evidence of any value as to the correctness of any mathematical theory of the effect of eccentric loadings.

It is interesting to note how a slight imperfection in the manufacture of a column affects its elastic limit without proportionately changing its ultimate strength. In Column IX the elastic limit was only 12,600 lbs., for $l/r = 97$, while in Columns III and IV where $l/r = 81$ it was about 24,000 lbs., the values of the ultimate being respectively 27,800 and 33,000 lbs. In Column XVII where $l/r = 45$ the elastic limit was only 19,000 lbs., while in Column XVI for $l/r = 46$ it was 25,500 lbs., the values of the ultimate being respectively 31,680 and 30,640. In the last comparison the defectively manufactured column gave the higher ultimate strength. As it is the elastic limit and not the ultimate strength of columns with which bridge engineers are concerned, it is evident how important it is to have every column of a structure checked carefully for straightness as a whole and in part. Again, it shows that long, slender columns are not consistent with good practice, because of their liability to be bent permanently out of line in transit or during erection.

The editor appears to have considerable respect for the Rankine-Gordon column formula. I never had much use for it, preferring the type first established by Thacher.

The importance of proper detailing of compression members cannot be too forcibly urged, especially in view of the Quebec Bridge disaster, which has been correctly stated in Engineering News to be due to glaringly unscientific proportioning and detailing of the compression chords. Correct bridge detailing is both a science and a fine art, and it should be entrusted only to those who have studied it deeply, and not to cheap draftsmen, as is too often the case. Every detailed connection that carries stress is or should be capable of mathematical analysis, and all the direct and indirect stresses and moments involved should receive adequate attention.

I agree most heartily with the statement that the engineering profession needs a thorough set of experiments on full-size columns. These should be made to represent the various compression members of bridges and the various types of section, and the pieces should be strained in the testing machine in the same

manner are they are in the structure. To what better use could Mr. Carnegie's investigation fund be put than the making of such a series of tests? It would be especially appropriate in view of the fact that a good share of his accumulated millions came from the manufacture of metal for the compression members of bridges.

COLD-ROLLED AND COLD-DRAWN STEEL BARS.

By ARTHUR J. WOOD,* M. Am. Soc. M. E.

About two years ago the writer made some cross-bending tests on compressed steel elevator guides. These guides were cold-drawn from hot-rolled stock of open-hearth steel of 0.12 to 0.15% carbon, the drawing being primarily for the purpose of producing a uniformly even and smooth surface. It was shown that, with supports 2 ft. between centers, the elastic limit point was raised over 100% as compared with plain hot-rolled bars. This result, secured by merely drawing hot-rolled bars, while cold, through dies, the action of which is by some supposed to produce merely a surface effect on the bars, was surprising.

The whole question at once assumed something of a scientific interest. A large manufacturing company was asked for its results along the same lines and the following information was received:

> While we admit the cold drawing process improves certain physical elements to some extent, this you will find is more apparent in cold-rolled steel. In fact, the latter is much superior and a comparison can hardly be made. We do not believe that the general results in tests referring to cold-drawn steel are any higher than for ordinary rolled bars, as the compression in the cold-drawn is only applied so as to provide a finish, while in the cold-rolled stock a much higher finish is given, which can only be secured by a higher compression, so far as our experience is concerned.

These questions at once were raised: What can be the difference in compressing the steel a certain amount by the action of drawing and that of rolling? Does the action of drawing merely produce a surface finish?

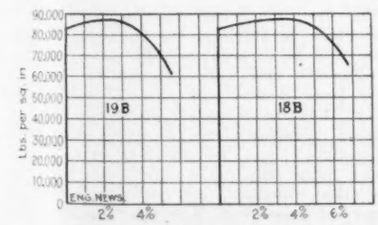


Fig. 3. Characteristic Stress-Strain Curves of Cold-Drawn Bars.

18 B, Round bar 0.8326-in. diameter. } Turned from 1-in. bars. Measured length, 8 ins.
19 B, Round bar 0.8365-in. diameter. }

Since then, from time to time, I have made or had undertaken by competent observers certain tests which have led to conclusions other than those in the letter cited above. The observations have been as follows:

A—By microscopic examination of polished pieces from different parts of the guides to determine the effect of the drawing in rearrangement of the carbon groups.

This study showed no marked changing of the groups. What there was, extended to the center of the guides; but these results should be regarded simply as an indication.

B.—By having hot-rolled bars of the same stock as that of the guides drawn through a die, thus reducing the cross-section the same as in the guides, and the two tested in tension for mechanical properties.

Typical results of these tension tests are shown in Fig. 1. The curves Nos. 1, 5 and 6 are from cold-drawn, Nos. 2, 3 and 4 from hot-rolled bars. Nos. 1 and 2 were taken with the Henning-Olsen extensomenter; Nos. 3 to 6 with autographic recording apparatus. The cold-drawn bars exhibit an increase of strength at elastic limit of 100%, which increase is secured at expense of ductility. The average elongation of all the cold-drawn specimens was 8¾%; of the hot-rolled 30.3%.

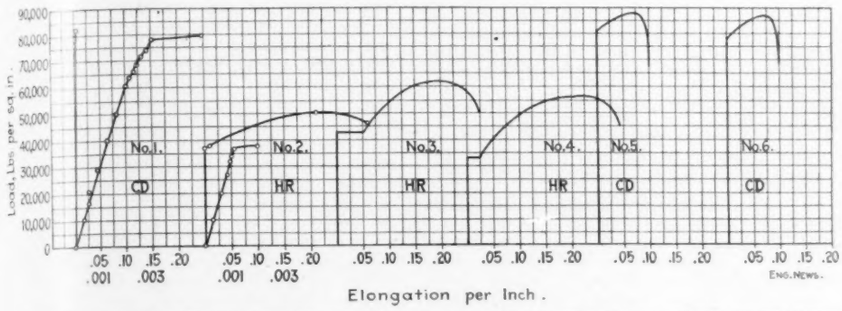


FIG. 1. STRESS-STRAIN CURVES OF COLD-DRAWN AND HOT-ROLLED STEEL IN TENSION.

Specimens about 1 × ½-in. in section, measured length, 8 ins.
Tests 1 and 2 with Henning-Olsen extensometer. Tests 3-6 with autographic recording apparatus.

C—By comparative tension tests of cold-rolled (CR) and cold-drawn (CD) stock. The results of these tests are shown in the following table.

Description.	Diam. of round bar from which test was cut.	Elastic Limit Strength lbs. per sq. in.	Ultimate Strength lbs. per sq. in.	Per cent. Elong. in 8 in.	Per cent. Red. of area.
C. D.*.....	1½-in.	63,050	70,240	10.0	38.1
C. R.*.....	1½-in.	62,140	70,240	10.0	41.3
C. D.†.....	1½-in.	64,520	74,190	10.0	45.0
C. R.†.....	1½-in.	62,480	72,500	10.25	41.3
C. D.....	1¼-in.	50,700	60,250	26.5	51.5
C. D.....	1¼-in.	50,780	61,400	25.0	52.2
D. & C. R..	1¼-in.	51,430	62,780	27.25	49.9
D. & C. R..	1¼-in.	52,080	63,020	25.75	49.2

*From same melt of steel.
†From same melt of steel.
Note: The first four tests were from soft Bessemer steel. The last four from open-hearth, about 0.25% C. and 0.026% P.

The tests of the Bessemer steels are strictly comparative for cold-rolled and cold-drawn, each pair being cut from the same bar. Judged from these specimens, the drawn and the rolled show practically the same physical qualities.

D—By turning test specimens from different sizes of bars, all cut from the same stock and noting the comparative test results as the center is approached.

Being convinced that no mere surface effect could produce such results as noted above and that the extended commercial use of cold-drawn steel was somewhat dependent on a metal fairly uniform in strength over the whole cross-section, further experiments* were undertaken.

We know that merely stretching a bar somewhat beyond its elastic limit and releasing the load, raises the elastic limit. Two hot-rolled bars were loaded beyond the elastic limit point, the load released and the bar restretched. The curve of one, 7 B x, a typical specimen, is shown in Fig. 2. A bar 7 B of the same material and the same size, $^9/_{16}$-in. diameter, was first broken. Its elastic limit was 10,000 lbs. (40,300 lbs. per sq. in.), its ultimate strength 15,400 lbs. (62,000 lbs. per sq. in.) and its elongation 19%. A similar bar, 7 B x, was stretched to 13,000 lbs. (52,200 lbs. per sq. in.), the load released and on again stretching, the elastic limit was found to have increased 12,000 lbs. per sq. in. over the elastic limit observed before stretching; the maximum strength was 15,400 lbs. (62,000 lbs. per sq. in.) and the elongation was 12%. The elastic limit was raised about 30%. This is a small gain compared with that obtained by the drawing process, indicating at once that drawing through the die raises the elastic limit both by the stretching *and by compressing* the metal, the latter effect being more important in the question of increase of strength.

Fig. 3 shows characteristic curves from cold-drawn specimens, 18 B being .8326-in. in diameter and 19 B .8365-in. Other values than those shown here are tabluated below. The curves, Fig. 3, are shown to bring before the eye the near approach of the elastic limit point to the maximum strength.

Referring to the table: All of the pieces tested were of nearly the same chemical composition as indicated, the "H R" being hot-rolled and "C D" cold-drawn. A number of bars were tested without turning down in the lathe, but these broke each time in the jaws of the testing machine. It will be observed that different sized bars turned to different diameters were tested. *In all the tests no appreciable decrease in either the elastic limit or maximum strength occurred as the center of the bar was approached.*

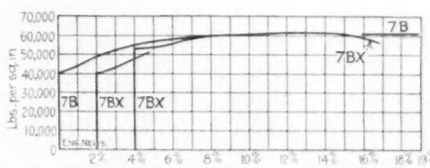


Fig. 2. Stress-Strain Curves of Hot-Rolled Steel, Showing Effect of Stretching Beyond Elastic Limit.

7-B, $^9/_{16}$-in. Round Hot-rolled Bar.
7-BX, $^9/_{16}$-in. Round Hot-rolled specimen loaded to unit stress of 52,200 lbs. per sq. in., released and loaded to rupture.

A study of the values given for these tests shows that by drawing the steel cold (reducing the diameter about $^1/_{16}$-in. in the bars) the strength at elastic limit is about doubled but the maximum strength is increased only 10 to 15%, a result not to be overlooked from the commercial side. The elongation of drawn specimens averaged from 5 to 6%, about one-quarter that of the hot-rolled pieces of the same composition. The reduction in area at breaking averaged 50% in the C. D., considerably less reduction than in the H. R. pieces.

Fig. 4 gives comparative curves of the elongation for each inch of the bar of the two kinds of steel. The decreased ductility of the cold-drawn bar is readily apparent.

E—By comparing the results found with those

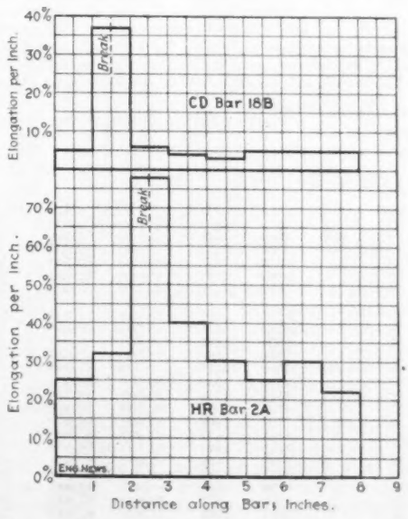


Fig. 4. Diagram of Elongations for Each Inch of Test-Piece, for 8-in. Specimens of Cold-Drawn and Hot-Rolled Steel.

*Assistant Professor of Experimental Engineering, Pennsylvania State College, State College, Pa.

*The following results are taken from the graduation thesis of Messrs. F. A. Dalburg and F. L. Lindemuth, presented last June to the Dept. of Mechanical Engineering, Pennsylvania State College.

contained in an elaborate series of tests made in 1902 under the direction of the late Dr. R. H. Thurston on cold-rolled steel, the points of similarity of cold-drawn and cold-rolled may be noted:

1. The external appearance of both is much superior to the hot-rolled.

2. The cold-drawn and cold-rolled are both turned out very close to gage; in fact, they can hold the size to within .0015-in.

3. The elastic limit is increased from 15 to 97% over the hot-rolled in the cold-rolled specimens, as reported by Dr. Thurston, while the average of tests from which Fig. 1 is selected is 100.5% and the average of the tests tabulated under D is 116%.

I am not trying to make an absolute comparison based on above values, for no two results can be fairly compared unless the amount of reduction of cross-section in the bars of the same composition is the same. My point is that the drawing in general produces a product that gives results at least equal to the cold rolling, so far as one may fairly judge from the tests.

GENERAL OBSERVATIONS.—It may be argued that what is described above is as old as the process of wire drawing itself. This is true, but it may also be remarked that the question of compression is not so important in the wire as in the larger bars, since the amount of drawing which the wire undergoes must cause compression to or near the center, which makes a new problem where the compression varies in amount for different sizes of bars used commercially.

Questions of effect on elastic resilience, modulus of elasticity, most desirable amount of drawing for different chemical compositions and different sizes of bar, may be raised, but these do not come within the objects of the tests here recorded.

The test-results and conclusions given above being submitted by the writer to one of wide experience in the manufacture of steels, the following were among the notes received:

Where the amount of reduction of cross section of area is the same for the cold-rolled as well as the cold-drawn bar, the average of the resulting data, from such tests, are practically the same. In other words, if a 1 in. diameter bar is reduced to $^{15}/_{16}$-in. by either rolling or drawing, the effect of the work on the bar, in either case, is the same, providing the bar throughout is the same consistency of metal, and the average data for such tests should be practically the same. If a bar of a certain diameter should be reduced $^{1}/_{16}$-in. in diameter, and a piece of the same bar reduced $^{2}/_{32}$-in., the second should show a higher elastic limit than the first, due to the greater stretch or reduction, or work performed upon it.

Commercially, cold-drawn material can be reduced cheaper, because the change is performed quickly and the reduction made in a single draft. Cold-rolled material must be made by numerous passes through the rolls, since the reduction must be gradual because the strength of the rolls, as well as the maintenance of uniform section, do not permit of cold-rolling in one pass. Cold-drawing produces more heat in the bar than cold-rolling, and it is therefore more difficult to hold the exact size.

It is significant to state that no comparative tests have been made in tension of larger diameters to show the difference between cold-rolled and cold-drawn material. The smaller sizes are generally drawn, while the larger sizes are rolled. The power units for drawing the larger sizes must be so great that few manufacturers are drawing the larger diameters.

In the smaller diameters, the results of treatment of both bars will more nearly be alike. The difference between the cold-rolled and cold-drawn bars of large diameters is due to the difference in preparing or producing same. In the one, the work is done gradually; in the other, at one draft. The drawn bars, in general, are brittle, while the rolled bars are tough. Cold-rolled material, in the larger diameters, is far superior in its resisting qualities to cold-drawn material. Take for example, a 2-in. rolled and a 2-in. drawn bar. The rolled bar can be twisted into a knot, while the cold-drawn bar cannot be subjected to this treatment.

The effect of both cold-rolling and cold-drawing is invariably to increase the elastic and ultimate resistances. It raises the elastic resilience or shock resisting power of the material within the range of permanent distortion. The breaking point is also raised. In tension, the elastic limit rises from a minimum of 15% to maximum of 97%, in excess of that of hot-rolled bars. The tenacity is raised 20% to 45% and the shock resisting power from ½ to 3 times that of the untreated hot rolled bar.

The ductility varies very nearly inversely as the elastic limit increases.

The modulus of elasticity is altered by increase of about 1,000,000.

THE DEVELOPMENT OF RAILWAY SERVICE IN AND ABOUT BUENOS AIRES, ARGENTINE REPUBLIC.*

The city of Buenos Aires, Argentine Republic, founded in 1535, had in 1870 a population of about 180,000. To-day, according to official statistics, the population within the city limits exceeds 1,100,000. The rate of increase, due to natural causes and to immigration, amounts to doubling every 13 years. Like most cities of relatively recent creation in the new hemisphere, Buenos Aires has had an advantage over European cities, as it has benefited largely, free of all earlier experimental costs, by the latest improvements in public works. However, it must be recognized that the citizens have been aware of the possibilities of modern engineering and business methods, and that the progress of the city is largely due to the exercise of considerable foresight.

Among the notable public works may be mentioned the port with its four large docks for transatlantic steamers, and modern drainage and water supply systems, and extensive railway networks connecting the capital with the fertile plains of Argentine and with the seashore, and joining the eastern part of Argentine with Chile, Bolivia and Paraguay. There is a large development in electric lighting and electric railway undertakings. It is stated that one of the greatest difficulties has been the meeting of the constantly increasing requirements of the rapidly growing country for all kinds of public services. For instance, the port works, which were built but a few years ago, and were considered at that time amply large for many years to come, have been so congested of late that many hundred thousand dollars have been lost to shippers and to the trade in general. However, at the present time, a new scheme for considerable enlargement, involving an outlay of $25,000,000, is being actively pushed forward. The building of new approaches for the railways and of new stations, the paving of considerable extensions of new streets, the supply of drainage and water for large new areas, the increase of electric lighting and the development of the telephone systems, are all now well under way. Increased facilities for the transportation of the populace within the city, and from the city to the suburbs, is also having adequate consideration. The magnitude of the traffic within the city itself is shown by the returns of 1906, which showed a movement of over 200,000,000 passengers by the street railways alone.

This figure is explained by the considerable area covered by the city, which is equivalent to not less than two-thirds of that of London and is consequently greater than that of large cities like Paris, Berlin, Glasgow or Vienna. Due to this great extension, to the warm climate and to the fact that the population prefers to ride even for very short distances, the needs of adequate transportation facilities have been particularly great. Owing to the arrangement of the streets, which are on the American checker-board system, and to their narrowness, the street railway lines have been distributed all over the city in such a manner that practically not a single important street is without its line. The street railway traffic as a rule moves in one direction only, and each line uses certain streets on its way out and different ones on the return trip.

One interesting point in connection with the original franchise was that it was granted to the concessionaire, Don Fedrico Lacroze, under the obligation of the exclusive use of horse traction. The reason for this stipulation was that is was necessary to develop the industries of the country, of which horse breeding was at that time among the most important.

In the early '90's, it was evident that horse lines were no longer capable of supplying the needs, and after some agitation the first line of electric railway was laid in 1897. Since that time practically all of the lines have been converted to electricity by various companies, mostly formed by English capitalists. The increased facilities thus afforded have not diminished but rather increased the congestion. The municipality, in order to relieve such conditions, has decided to construct a vast system of diagonal avenues and of street widenings, for the planning of which the services of the eminent Paris architect, M. Bouvard, have been retained. This scheme when carried out will cost many millions of dollars and will change the whole aspect of the city.

The first line which Lacroze built ran from the Plaza de Mayo to the Plaza de Setiembre. This line he afterwards sold to the Anglo-Argentine Co. and it became the nucleus of the very large system now operated by that company. Lacroze developed his lines into a large system operating under the name of the "Rural Tramways," and in addition extended them many miles into the country, at a time when the other companies did not realize the importance of possessing adequate suburban communication. The undertaking grew to a point where it became necessary to form two different systems, "The City Tramway Lines," now known under the name of the "Buenos Aires Lacroze Tramways," and a steam railway line, extending from Chacarita Station in Buenos Aires to Salto and to Zarate, a total length of 85 miles. This steam line, long known as the "Tramway Rural à Vapor," has recently been organized into a new company called "Ferro Carril Central de Buenos Aires, Limitado."

The original horse railway was extended by degrees under the old concession for a distance of upwards of 100 mi. into the country, and there can be no doubt that this line holds the record for long distance car service by horse

*From information supplied by Messrs. J. G. White & Co., London, England.

COMPARATIVE TENSILE TESTS OF COLD-DRAWN AND HOT-ROLLED STEEL.

CD = Cold-drawn.
HR = Hot-rolled.

Material, open-hearth steel; composition, about as follows: C, 0.08 — 0.11%; P, 0.10 — 0.11%; Mn, 0.60 — 0.80%; S, 0.06 — 0.10%.

Ref. No.	Kind.	Diam., Ins.	Area of Section, Sq. Ins.	Strength in Lbs. per Sq. In. El. Lim.	Maximum.	Breaking.	Elong., Ins.	Red. of Area, %	Remarks.
1B	HR	.9360	.679	35,800	62,100	49,600	...*	58.5	Turned from $1^{3}/_{16}$-in. bar.
2		.8580	.578	37,000	67,800	53,600	...*	55.9	Turned from $1^{3}/_{16}$-in. bar.
3		.9517	.711	37,000	67,700	54,400	...*	55.6	Turned from $1^{3}/_{16}$-in bar.
4		.8862	.617	27,600	52,500	42,200	...*	65.1	Turned from $1^{3}/_{16}$-in. bar.
7		.5637	.249	40,000	63,600	56,200	...*	49.3	Turned from $1^{1}/_{16}$-in. bar, broke below clamp.
9	CD	.9276	.676	72,400	74,700	57,300	...*	52.6	Turned from 1¼-in. bar.
10		.8281	.552	67,100	70,400	55,400	...*	52.7	Turned from 1¼-in. bar.
11		.9354	.687	78,600	80,200	64,000	...*	50.5	Turned from 1¼-in. bar.
13		.8898	.636	74,500	79,800	60,700	...*	49.8	Turned from 1¼-in. bar.
16		.7540	.447	82,700	87,200	65,800	4.6	47.6	Turned from 1-in. bar.
17		.8390	.580	80,500	88,000	72,000	...	16.2	Turned from 1-in. bar.
18		.8326	.544	83,900	89,500	66,700	6.4	42.6	Turned from 1-in. bar.
19		.8315	.543	82,900	88,000	62,900	7.6	50.4	Turned from 1-in. bar.
20		.7703	.466	83,600	88,000	73,600	5.0	31.9	Turned from ⅞-in. bar.
21		.7463	.437	82,400	87,400	74,500	...	34.4	Turned from ⅞-in. bar.
22		.7493	.411	82,700	88,000	76,400	5.8	48.6	Turned from ⅞-in. bar.
23		.7705	.466	82,600	87,600	73,900	6.2	38.7	Turned from ⅞-in. bar.
24		.6954	.348	80,000	93,700	68,400	5.3	47.2	Turned from ¾-in. bar.
25		.6678	.350	90,500	93,000	71,000	4.2	47.9	Turned from ¾-in. bar.
26		.4752	.177	76,800	85,800	66,600	5.0	48.4	Turned from ½-in. bar.
27		.4645	.169	76,800	85,300	79,200	...	36.4	Turned from ½-in. bar.
28		.4654	.170	74,700	82,300	70,400	...	46.1	Turned from ½-in. bar.
29		.4654	.170	76,400	84,700	76,400	...	22.2	Turned from ½-in. bar.
30	HR	.8207	.529	45,100	68,900	50,100	...*	63.6	Turned from $1^{1}/_{16}$-in. bar.

*3-in. specimen.

traction. In addition, it is claimed that the Rural Tramway can boast of having been the first horse railway to run a sleeping car over its lines.

THE BUENOS AIRES LACROZE TRAMWAYS.

After the death of Don Fedrico Lacroze the control of his systems fell into the hands of his sons. One of their first steps was to make contracts with Messrs. J. G. White & Co., of London, for the reconstruction and electrification of the old city lines, under the name of the "Buenos Aires Lacroze Tramways." The new lines are laid in the new portions of the city where the streets are wide enough to accommodate a double track. The work was commenced in March, 1906, and before the end of that year a 2,250-KW. power house was in running order. Considering labor troubles and

FIG. 1. PAVING BETWEEN TRACKS, BUENOS AIRES, ARGENTINE REPUBLIC.

port congestion, this is considered a distinct achievement. Part of the lines were opened formally to public traffic on March 10, 1907, and since that time the traffic has increased beyond all expectation. The original lines consisted of 15.5 mi. of track, owned by the company, and about 4 mi. held jointly with other companies and on lease.

The contractors are now engaged in extending these lines a further distance of 25 mi., the franchise for which extension was granted in 1905. For the purpose of serving these new lines, another 750-KW. generating set is being added to the power station.

TRACK WORK.—All the lines are laid to a gage of 4 ft. 8½ ins. The rails weigh 87 lbs. per yd. The first shipments were in 45-ft. lengths, but on account of shipping difficulties, later shipments were made in 40-ft. lengths.

The rails are laid on concrete stringers 6 ins. deep and 16 ins. wide. The greater part of the paving has been done with granite sets, the sets being rammed with the implement shown in Fig. 1, operated by four men. The tiebars are 2 × ¼ ins. spaced at intervals of 3 ft. 9 ins.

The rails are bonded by two concealed bonds. Gradients offer no difficulties since the track is practically all laid on the level. The radius of the sharpest curve is 45 ft.

OVERHEAD EQUIPMENT.—The overhead equipment consists of side poles with span wires, and a center or side pole construction with bracket arms. The poles are of steel, are made to the British standard specification and are 30 ft. long in three sizes. The trolley wire, 00 B. & S. gage copper, is strung at a height of 20 ft. 6 ins. from the ground.

POWER HOUSE.—The building itself is of heavy brick and steel construction with the exterior plastering usual in Argentine. In the engine room are three 1,100-I.HP. horizontal cross compound engines direct connected to 750-KW., 550-volt generators. Each engine has its own condensers. The condensing water is cooled in two natural draft cooling towers of wood.

In the boiler house are installed, with room for extensions, five marine type Babcock & Wilcox boilers fitted with superheaters. Each boiler is capable of evaporating 12,000 lbs. of water per hr., the grate area and heating surface being 49 and 2,480 sq. ft. respectively.

ROLLING STOCK.—For use in the city 140 Brill semi-convertible cars will be provided each having a seating capacity of 32. The truck carries two 40-HP. motors.

In addition to the city cars there will be at first ten interurban cars similar in general appearance to the smaller ones, but seating 44 people and equipped with two trucks each carrying two 50-HP. motors. These cars will be capable of maintaining a speed of 40 mi. per hr., and will be operated to an important suburb over the steam line of the Ferro Carril Central De Buenos Aires as noted later.

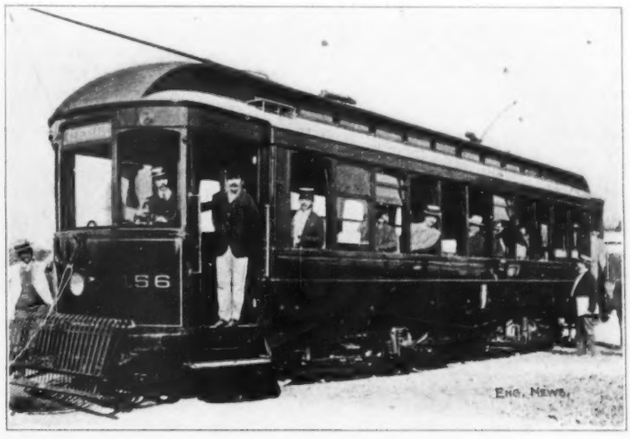


FIG. 3. TYPE OF INTERURBAN CAR USED ON THE BUENOS AIRES STREET RAILWAY SYSTEMS.

Electric locomotives will be used for the increasing freight business from the outside lines. The type employed has a central cab mounted on two four-wheeled bogie trucks and has an equipment of four 50-HP. motors.

FERRO CARRIL CENTRAL DE BUENOS AIRES.

This line, formerly the "Tramway Rural à Vapor," is a standard gage road extending westward and northwestward in the Province of Buenos Aires, from Chacarita Station in the city of Buenos Aires to the town of Salto, a distance of 105 mi., with a branch 27 mi. long to Zarate, a town on the Paraná River, and a

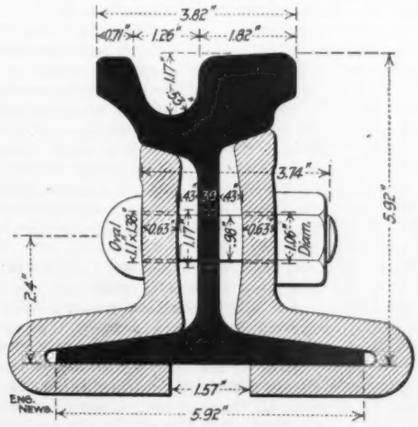


Fig. 2. Cross-Section of Girder Rail for City Tracks of "The Buenos Aires Lacroze Tramways."

branch of 1.9 mi. from Lynch to the suburb of San Martin. It traverses one of the most fertile districts in the Argentine.

The history of the railway is believed to be quite unique, in that it was constructed as an extension of an urban horse railway from the surplus earnings of the latter, and was operated as a horse tramway for freight and passengers for a considerable distance in a then thinly settled country. In 1884, Don Federico Lacroze, whose horse tramway was the pioneer among the street railways of Buenos Aires, and who owned at that time, as has been noted, an extensive system in the city, obtained a concession to build the "Rural Tramway," to start from Chacarita, then the most westerly point on his lines. In Buenos Aires province it is cheaper to build a railway than a good road. Lacroze saw the opportunity for supplying a method of transportation much cheaper and much more rapid than then existed, to a large, fertile and rapidly developing agricultural zone. Construction proceeded as fast as earnings became available for that purpose. From 1885 to 1892, 60 mi. of main line, the San Martin branch of 1.9 mi. and the Zarate branch of 27 mi. were built, a total of about 89 mi. From 1892 to 1895 the main line was extended to the 83d mile, and by 1897 the present system of 137 mi. was entirely in operation. The early type of construction was necessarily as inexpensive as possible, the rails weighed 30 lbs. per yard and the sleepers were creosoted yellow pine 6.5 ft. long. The bridges were little more than wooden stringers decked over. Earthwork was avoided as much as possible, the track being laid practically upon the ground.

It became evident as early as 1891 that it would be necessary to introduce steam traction in order to accommodate the traffic. Accordingly, eight 16-ton saddle-tank engines were bought from the H. K. Porter Company, Pittsburg, U. S. A., and the bridges were strengthened to receive them. With the earnings of these eight locomotives, in 1896 three 18-ton passenger locomotives were acquired, the railway was rapidly developed, gradients were reduced, new rolling stock purchased and a handsome new passenger station was built at Chacarita. A large and modern fireproof freight station was built in the heart of the city of Buenos Aires, 31 mi. of line was relaid with 50-lb. rails and the 29 mi. extension from Salto to Rojas begun.

The Ferro Carril Central De Buenos Aires is at present in transition from a light railway to a standard heavy railway. This period is appropriately marked by its being transferred in July, 1906, by Messrs. Lacroze Brothers & Co. to the new company, the old name of "Tramway Rural à Vapor" disappearing.

This period of transition was occasioned by an agreement with the Entre Rios Railway. The latter, founded as a provincial government railway in 1883, but now an English company, operating some 480 miles of standard gage line, has always been a purely local enterprise, being segregated from the city of Buenos Aires, as well as from the rapidly developing provinces of Buenos Aires and Santa Fé by the great Paraná River, which interposes, not only its own great width, but also a belt of swampy

land 35 to 40 mi. wide, as a barrier along the entire western and southwestern sides of the province of Entre Rios. Similarly, the northern connections of the Entre Rios Railway, the East Argentine Railway, 99 mi. long, and the Northeast Argentine Railway, 411 mi., all standard gage, are entirely separated from the rich central provinces of the republic.

An extension is also under construction from Santo Tomé, the extreme northeastern point of the northeast Argentine Ry. northward to Posadas, where, by transfer across the Alto Paraná to Villa Encarnacion, it will connect with the 250 miles of the Paraguay Central Railway, also standard gage. Thus, there was a system of railways, present and prospective, of about 1,400 miles, awaiting an entrance into the province and city of Buenos Aires.

Under these circumstances, the Entre Rios Railway made a contract with the Ferro Carril Central De Buenos Aires by which the former will deliver its trains to the latter at Zarate to be hauled into Buenos Aires.

Expensive works have been undertaken for carrying out this programme and are now well under way. The Entre Rios Railway is extending its lines to Ibicui, a point on the Paraná delta opposite Zarate. There it is building a port and ferry slip, and at Zarate it is building another ferry slip; between these points will ply a large steel transfer ferry boat, with a capacity of about thirty freight cars. The ferry boat for this service was built in Scotland, and proceeded to Argentine under her own steam, arriving in May. From the ferry boat at Zarate, the Entre Rios Railway is building a connecting line up to the top of the bluff, where it joins the Ferro Carril Central. The latter is reconstructing its entire permanent way between Buenos Aires and Zarate, 62.5 mi., using new hardwood sleepers of full size, closely spaced and 70-lb. rails.

ARTESIAN WELL PUMPING BY COMPRESSED AIR.

By H. TIPPER,* M. E.

The economics of artesian well pumping is, particularly to the people of the Southwest, an important question. There is only a small amount of surface water in that district and of that none can be used safely without thorough purification. Artesian water can be obtained with ease, in a great majority of cases, and while it may contain permanent and temporary hardness, it is free from all dangerous contamination.

Engineers, independently of the large manufacturers of compressed air apparatus, know very little about lifting water by air, and the writer has observed case after case where this has been the cause of disastrous and costly experiments, both in private and city plants.

The proper proportion of air and water pipes, the proper submergence, the condition of the casing, and the style of lift used are points which appear to receive vastly too little attention from the people in charge, with the result that the practice of using compressed air gets saddled with faults not of its making.

The assumption that an air-lift system is getting the best efficiency of a well because the water is being delivered and there is no apparent defect is responsible for the absence of any general reliable data from independent sources on this subject, at least so far as it pertained to the Southwest, and it is to state the conditions in this territory, as found by the writer, that this article is written.

The sands from which the artesian water is secured in the State of Texas vary largely in their textures, their static head and the depth at which they are found. Thus, at El Paso there are four or five water-bearing strata within 300 ft. of the surface, and the static head from any of these comparatively small. North Texas is supplied from the Trinity sands and from the Paluxy sands. Of these sands the Trinity sands are the greatest and most important. Borings have been made and artesian water supplied from these sands in the larger part of Texas, including Fort Worth, Dallas, Waco, Austin and San Antonio. The Trinity sands are generally a white quartz, but vary greatly in texture, in different portions of the strata.

In addition to the cities named, a number of smaller towns, and a larger number of private plants, take their water from the Trinity strata.

In Fort Worth the depth of the sand from the surface is about 1,000 ft. and the static head about 900 ft.; in Dallas the depth is almost 2,000 ft., and wells have flowed there with a 100-ft. head pressure.

In Waco the wells all flow, though not sufficiently to be able to supply the town without pumping. All along these sands the conditions are good for artesian pumping with compressed air. In the first place the lift is not more than 150 ft. The submergence can be placed at the most economical point, and the water which is secured is of excellent quality.

It has been necessary for the writer in the course of business to investigate the condition of numbers of wells, and in very few cases, so few as to be hardly worth considering, have the wells been in a condition which would make economic pumping possible. The chief difficulties found are:

(1) Bad casings. In a large majority of cases the wells had been shot with dynamite at the least suspicion of not delivering the required amount of water. Frequently this has been done carelessly and in such a manner as to irreparably damage the casing, and allow the air to escape into the surrounding strata instead of being engaged in lifting the water. In many instances the casing had been allowed to rust and become perforated with holes so that it was of no value for use with an air-lift. There seemed to be little or no attempt to keep the casing in good condition.

(2) Badly proportioned air and discharge pipes, and poor arrangements of pipes. The use of air pipes of altogether too small diameter is common. This causes a frictional resistance of a very expensive character. There may also be noted an absence of any attempt at proportioning the discharge pipe so as to get the most economical delivery of water from the well.

(3) The choking of well with the remains of rotted pipes and former attempts at pumping. It is surprising how often this occurs.

(4) The absence of any tests, or any means of ascertaining comparatively the performance of an air-lift at one date with another.

It is absolutely amazing how much in the dark the people using artesian water frequently are as to the amount received. Even in large cities like Ft. Worth and Waco there are no records of tests made on the wells to ascertain the amount of water received or the cost of obtaining it.

The cost of obtaining water from the artesian strata by air-lift varies with the lift and submergence, but in the average a great deal of the cost is due to neglect. In my investigations of the subject I have found that the efficiency of the air-lift in moving water from the same strata practically through the same lift and under similar conditions runs all the way from 5% to 25%.

The cost of delivering the water, depends in the first case on the compressor, and the great difference in compressors allows of some consideration of that subject.

The volumetric efficiency of the air cylinder of a 250-cu.-ft. compressor ought to reach 85%, yet I have found that badly constructed valves and long narrow heated parts have reduced this to 40% in several cases.

The intake valves of the compressor should be a large part of the cylinder area, they should be placed and posted so that the rise in temperature of the air before it reaches the cylinder will be a minimum. They should, if possible, provide against any chance of irregular wear. The discharge valves should leave as little as possible of clearance so as to keep the volumetric efficiency high and should be kept away from the intake valves.

It cannot be regarded as good construction for the intake and discharge valves to use the same ports; as the passage of the heated air, when discharged, over the metal, over which the intake air must afterwards pass, results in the heating and expansion of the incoming air unnecessarily and consequent loss of efficiency.

The state in which compressors are allowed to run is one of the marvels which keeps an engineer guessing. While the steam engines of the plants receive the best attention, too often the compressor must take care of itself, and it is to be regarded as to the credit of compressor manufacturers that they stand the strain so well. I have seen compressors running with the intake pipes open not 6 ft. from a boiler furnace, absorbing all the dust from the boiler front and running it into the cylinder to the detriment of valves, cylinder and all other parts around the cylinder. In the same place was being used, in the air cylinder, a thick black steam cylinder oil, and the thick oil and dust must have formed an excellent grinding material round the piston.

The next question relates to the piping of the well, and here a great deal of damage is done and a great deal of unnecessary expenditure incurred. I counted in four weeks, in this territory, over 25 cases where air lines of 1 in. had been used to supply air for 6-in. wells, with the inside air-line system. The average length of the pipe was 350 ft. from the well top; and often it was another 300 ft. to the compressor. Figure out the frictional loss occasioned by this, and the additional load thrown on compressor by the loss. These wells were pumping an average of 75 gals. per min. and using a compressor delivering 200 cu. ft. for the work, with a net efficiency of about 6½%. After altering one of these pipes to a 2½-in. pipe above the well, putting in a receiver storage at the discharge of the compressor, and putting a 2-in. pipe down in the well, the average delivery reached 180 gals. per min. with the use of a little less than 200 cu. ft. of free air, the efficiency in this case being about 23%.

In another case I found two wells of different depths, worked by different pressures, being fed from the same pipe, with of course the absolute loss of one well.

In experimenting with the matter I have found that a large receiver capacity, and a large pipe above ground, a 55% submergence and a frictional loss of not more than 5% allowed for in the piping proportions in the well bring the best results. With these and a lift of not more than 200 ft. I have been able to get an average of at least 1 gal. of water per cu. ft. of air per min.

The use of long lines of discharge pipe from the well horizontally, instead of allowing the well to discharge into a basin and the water to flow thence by gravity or be pumped by separate pumps to its required place, have a bad effect on the efficiency of the air-lift and should never be used. The most efficient scheme is a straight lift either to surface or elevated tanks, all long horizontal work to be taken care of by separate pumping system.

The ultimate economy of the air-lift as compared with pumping jacks, or with deep-well pumps, whether steam or electrically-driven, depends not at all on the efficiency, as percentage for percentage it is the most expensive system of pumping. Its utmost efficiency is not more than 25% to 30%, while that of deep-well pumps, especially of the double-acting type, runs very much higher. The economy in the air-lift lies in its power of supplying a much greater quantity of water from the same sized well than the deep-well pumps, except in cases of low submergence, when it is useless to install the air-lift.

Not being limited to a certain displacement capacity, the quantity of water that can be raised by the air-lift is limited only to the amount possible for that sized pipe to carry at the velocity reached from the pressure of air employed. There is also economy in the absence of working parts down in the well and in saving frequent repairing to these with great loss of time and money. Properly installed and properly attended to, the air-lift system of delivering artesian water, while mechanically inefficient, represents the least troublesome, most desirable and most easily looked after system of obtaining the water under these circumstances at present in use.

*Fort Worth, Tex.

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What Dogberry would call an "odorous" comparison has been circulating recently through the daily press in regard to the excavation of the new Western Pacific Railway through the foothills of the Sierra Nevada Mountains and the excavation on the Panama Canal. The following extract from the New York "Times" will serve for an illustration:

> Mr. George J. Gould congratulates the officials of the Western Pacific Ry. because with 8,000 men they have moved more earth and rock than the Panama Commission with a force of 30,000 laborers. The Western Pacific record for the first eleven months of the year was 11,471,300 cu. yds., more than half of which was rock, as compared with the 8,151,645 yds., chiefly of dirt, removed in the same period by the Panama Commission; and in addition to this three miles of tunnels were driven, 200 miles of main line track were built and ballasted, and immense quantities of stone masonry, steel bridges, and other construction works were erected.

As this comparison is being made use of as proof of the inefficiency of Government administration on the Isthmus, it is proper that attention should be called to the many inaccuracies in the comparison.

In the first place the conditions of working are so widely different on the two enterprises that no fair comparison can be made. On the one hand a railway line, is being built by experienced and efficient railway labor, through a semi-arid, healthful country, in easy reach of a base of supplies, and with short hauls from cut to fill; on the other hand a wide and deep ship canal is being dug in the most part by inexperienced, untrained tropical laborers, far from a home base, through a tropical country with an enormous rainfall, where conditions of climate are particularly enervating, and where the hauls often reach as high as ten miles.

But aside from all this, the above newspaper statement of work on the Isthmus is far below the actual excavation. According to the "Canal Record" for Dec. 4, 1907, the official record of excavation during the eleven months from January through to November, 1907, is as follows: Total steam shovel excavation, 9,550,479 cu. yds.; total dredging, 4,006,254 cu. yds.; grand total, 13,556,733 cu. yds.

Of this 9,550,479 cu. yds. of steam shovel excavation, 8,151,645 cu. yds., or the amount accredited in these newspaper articles to the entire canal, was excavated in the Culebra cut, and instead of being "chiefly dirt" it was, according to official statements, 58% rock.

There were working on the Culebra division during the fiscal year 1906-07 an average of 4,684 men, and allowing an increase to 5,000 men for the five months, July to November, the 8,151,645 cu. yds. of hard material, 58% rock is not a bad showing in comparison with the 11,471,300 cu. yds. excavated by 8,000 men on the Western Pacific Ry.

Again, instead of the "30,000 men" reported above, there were in June, 1907, 23,327 men employed by the Government in the entire Canal Zone, according to the annual Report of the Canal Commission, and the average for the year was much below this. Of these men over 2,000 were employed in the Department of Sanitation and nearly as many in the Department of Labor and Subsistence, leaving less than 19,000 as the force in construction and engineering work for the entire Isthmus.

It may be noted also that only now, at the close of the year, is the working plant—steam shovels, cars and locomotives—on the Isthmus reaching a point where full capacity can be expected, as is evidenced by the rapidly growing rate of excavation reaching 2,200,539 cu yds. in December as noted in our last issue.

As we have said above, comparison of total excavation on the two pieces of work is comparing things so dissimilar that no deductions whatever are justified. The newspapers are censurable for misleading their readers with figures far from the truth and comparisons which appear plausible enough to a layman, but which any engineer knows to be unreliable and misleading. Still more are they censurable when they build political argument on such weak foundation as for example the New York "Times," which says:

> But for the contrast it affords with an expensive and much-heralded public work this record of private accomplishment and economy might pass unregarded. It furnishes a gage by which Mr. Bryan and the other advocates of Government ownership of railroads, and their hearers, may measure the merits of that plan.

It seems a pity to weaken the case against Government ownership by such ill-founded arguments.

The economic and sanitary value of a plentiful supply of moderately-priced ice is not generally recognized, but judging from recently published U. S. Census statistics the demand for ice has been rapidly increasing of late. These statistics, selections from which are printed elsewhere in this issue, deal with manufactured ice, only. The large number of ice-manufacturing plants in the Southern States is significant, but compared with the needs of that section the output of those plants must be very inadequate. For obvious reasons, but little natural ice is used in the South, and since the warmer climate of that section makes the use of ice more necessary than in the North, both in quantity per day and in number of days per year, it follows that per capita production of artificial ice ought to be much higher in the South than in the North. While the bulletin states that, in proportion to population, this is true, the statement applies to number of plants and not to tons of ice. Without taking into account the relative percentages of urban population in both sections of the country, and at the same time allowing for the natural ice consumed in the north, and for various other factors, no accurate comparison could be made between the relative extent to which the ice-needs of the North and the South are being served. But unquestionably the South is in great need of many additional ice-manufacturing plants.

From the sanitary, and perhaps from the economic viewpoint, also, the South is in particular need of abundant and low-priced ice to aid in working much-needed improvements in the milk supplies of its cities. A bulletin on the "Milk Supply of Two Hundred Cities," issued a few years back, showed that the per capita milk supply of many Southern cities was very small, and that much of the little milk consumed was of poor sanitary quality. The scantiness and the poor quality were both attributed, in greater or lesser degree, to the lack of ice for cooling milk and for keeping it cool. Even in the much cooler climate of the North it is now deemed essential to the public health that milk be brought to a temperature of 50° F. within an hour of the time it is drawn from the cow and kept at that temperature until it is consumed. With the higher temperatures of the South, obviously, milk suffers far more and far more speedily in quality if it is not cooled and kept cool.

It is a remarkable fact that a number of Southern cities enjoying a seemingly unquestionable water supply have very high typhoid death rates. Why this should be so is an interesting and important question. If all the data needed to answer this question were available they would throw a flood of light on other sanitary problems of Southern cities. They would show, we believe, that digestive disorders other than typhoid fever, and particularly those of children, could be greatly reduced by means of well-known and easily applied health-protective measures. They would show a great need for improving the character of the milk supply throughout the South, and would indicate that much of the needed improvement in the milk supply in particular and in some other sanitary matters in general, depends upon the provision of an adequate low-priced ice supply. As matters now stand, a most important food material is not used to anything like the extent that both economy and health demand it should be used, and much of the milk that is consumed is a serious menace to health.

In conclusion, it is only fair to the South to state that most of the foregoing remarks apply equally to other parts of the country, except in so far as they have a more abundant ice supply, in proportion to their needs.

Elsewhere in this issue is given a brief outline of the development of street railway facilities in the city of Buenos Aires, and of new railway construction in that part of Argentine. One thing is striking about this development—the absence of American machinery. In the case of the city traction work, the rails came largely from Belgium and Germany, the compound engines in the power house from Belgium and the auxiliary apparatus mostly from England. The generators, in the power station, and the street cars, appear to be practically all the machinery coming from the United States. Of course the small part played by United States engineers and manufacturers in South American markets is an old story; but it is one which will bear repetition until American enterprise is turned in that direction.

A REVIEW OF PROGRESS IN AERIAL NAVIGATION.

To most persons the reference to aerial navigation brings to mind first recollections of a county fair balloon ascension and the accompanying sensational parachute drop. The publication of actual developments in flying machines has been made in such exaggerated shape that the truth behind has not been generally recognized or indelibly impressed on readers of such reports. The real progress toward artificial flight, then, needs to be occasionally reviewed.

The recent publication of specifications and advertisement for an army airship, which is in no sense a balloon, probably came as a surprise to many. Those persons with at least a superficial knowledge of the state of the art of aerial navigation will probably believe that the Signal Office is taking this course to rid itself of the appeals of enthusiasts who have machines which they wish to have tested at Government expense and whether this call for a Government flying machine is issued as a defence from cranks or whether the state of the art really warrants serious effort by the Government to obtain a flying machine for military purposes is a matter on which opinions will probably differ. Reports state, however, that the Signal Office has received daily upwards of 40 letters about these machines. As an attempt at relief from cranks then the futility of this move must have been foreseen.

Aeronautical practice of the present time easily divides itself into three lines of work with distinct types of apparatus, common balloons, dirigible gas bags and "heavier-than-air" flying machines. No little publicity has been given to recent balloon work and while greater skill and knowledge in handling these great gas bubbles is evident than ever before, yet the apparatus is much the same as that devised and used 125 years ago.

With balloons, far greater altitudes can be reached than it seems probable any true airship could possibly attain. The simple balloon has greater inherent safety and stability than any dirigible or airship and greater ease of control in so far as it can be controlled at all.

The desire to make an airship which can go where its navigator desires and not simply float with the winds has led to the various dirigibles with their peculiar elongated supporting body and comparatively small propelling and steering apparatus. At a thorough discussion of the early dirigibles has appeared in this journal,* it means worth while merely to mention here the names of Giffard (1852), Dupoy de Lome (1872), and Tissandier (1883), as having built dirigibles and operated them with some little success. Captains Renard and Krebs' airship "La France" deserves somewhat more notice as the immediate prototype of the successful dirigibles of the present day. These men built so skilfully that their feats with "La France" have not yet been greatly exceeded. The supporting body of their airship was 179 ft. long with a maximum diameter of 27.5 ft. A stiffening frame 128 ft. long formed their car. With a 24-ft. propeller driven by an 8.5-HP. electric motor at 46 r. p. m. a speed of about 15 mi. per hr. was attained.

Among the most notable experiments with dirigibles should be noted those of Alberto Santos-Dumont which resulted in his winning the Henri Deutsch prize of 100,000 francs at Paris in 1901. His designs were evidently founded on the work of Renard and Krebs; and while it is often stated that his gas bag itself was in many ways inferior to that of "La France," yet with a superior source of power their record was greatly exceeded. Santos-Dumont travelled from St. Cloud to the Eiffel Tower with the wind in 8 min., 45 sec., circled the tower and returned against the wind in 20 min., 30 sec. and descended in 1 min. 40 sec. His gas bag was smaller than that of "La France," being 111.5 ft. long by 20 ft., maximum diameter. The propelling screw was 13 ft. in diameter and was driven by a 16-HP. gasoline motor at 200 r. p. m. Space can hardly be given to an enumeration of all the subsequent dirigible balloons which have been wholly or partially successful. However, the names of Von Parsifal and Count Von Zeppelin, both in Germany, and of Henri Deutsch, Count de La Vaulx, the Lebaudy brothers and their engineer Julliot, all in France, should be mentioned as noteworthy experimenters.

Count Von Zeppelin in 1900 made several successful trials at Lake Constance, reaching a height of 2,000 ft., ascending and tacking against a 7-mile breeze. It is reported that, under the most favorable conditions, he attained a speed of 30 mi. per hr. The long supporting body with an aluminum frame contained 17 balloon compartments. A ventilated air space between these gas compartments and the covering spread on the aluminum frame prevented any great disturbance resulting from the action of the sun's rays. Two gondola shaped cars suspended from the framework were each equipped with a 15-HP. gasoline engine driving a horizontal shaft which carried fore and aft propellers. Auxiliary screws were provided on the sides of the cars for steering.

In the Lebaudy dirigible "La Patrie" the design of "La France" was substantially improved by perfecting the apparatus for steering, both horizontally and vertically, and by the addition of devices to maintain an even keel.

Sir Hiram S. Maxim's big aeroplane is credited as being the first true flying machine to leave the ground. The lifting power developed overcame the restraint put upon its ascent and it was wrecked in consequence of its overdoing. When Maxim first started his experiments little was known of the properties of aeroplanes and aerial propellers and the modern internal combustion engine was entirely undeveloped. A steam boiler and engine were designed, remarkable for lightness in comparison to the boiler and engines of that time. This apparatus was the forerunner of the steam-automobile boiler and engine as they exist now. By 1890 Maxim's investigations were well under way and his power apparatus was all designed. In 1894 Maxim gave an exhibition of a huge machine weighing, when loaded with three men, 200 lbs. of naphtha fuel and 600 lbs. of water, a total of about 8,000 lbs. A wing area of some 4,000 ft. was designed to develop a lifting force of 10,000 lbs. It will be remembered that the machine broke through the inverted track, intended to limit its flight for these experiments, turned crosswise and was so badly wrecked that little further has been done with it. The results of this pioneer work, however, became available to later experimenters and have served as a basis of later developments.

About this time Otto Lilienthal came into notice with his "artificial birds,"—huge, man-carrying, soaring kites designed to closely imitate the soaring flight of certain birds. Lilienthal did not attempt propulsion by aerial screws but confined himself to flapping and soaring flights. The characteristics of his designs seemed to be short fore and aft dimensions and a considerable stretch across the wings. As he was not able to manipulate such a strictly bird-like apparatus with the skill of one "born to the air," he was killed during flight. The least that can be said of his experiments is that they indicated a definite field of work to a group of successors who, profiting by his experience, have achieved remarkable results if we may rely on the very meager but apparently reliable evidence.

The next important contributions to the science were in the efforts from 1890 to 1895, of the late Professor S. P. Langley, Secretary of the Smithsonian Institution at Washington. The experiments with model "aerodromes" were entirely successful, but the manipulation of the full sized machine brought practical difficulties which were not surmounted through lack of funds when the death of the inventor occurred. Langley's large machine was 12 ft. long and 8 ft. wide with four stationary wings and a steering pair about half the size of the larger ones. Steam power was used to drive two small wooden propellers. Mr. Chas. M. Manley, for seven years associated with Professor Langley on this work, is authority for the statement that the failures were of the launching apparatus rather than of the "Aerodrome" itself and that the work with this type has not been abandoned but only suspended. Langley's experiments are admittedly the most thorough and scientific ever made in this field and, while no practical commercial machine was developed, the design of lifting planes was placed on a more exact and well defined basis.

Among the immediate successors of Otto Lilienthal, Messrs. Octave Chanute, A. M. Herring and the brothers Orville and Wilbur Wright, all working in this country, seem to have carried the sailing and soaring type of machine much nearer practical success. The most typical and successful machines of this type are possibly those of the Wright brothers. Few authentic data are available and knowledge of this machine comes through the statements of a few non-technical men near Dayton, Ohio, and of aeronautical experimenters like Mr. Octave Chanute and Dr. Alexander Graham Bell. For some unexplained reason, the Wrights hold to the view that a public demonstration before technical experts would impair the results of their work and tend to rob them of their legitimate reward. It is stated that the Wright "flyers" are smaller than the Maxim and Langley machines and larger than the Lilienthal artificial birds. The few available pictures and descriptions show the construction as a double decked arrangement of aeroplanes concave downward, with a horizontal rudder. In 1903 they built a flyer which they state with the operator weighed 745 lbs. Its longest flight was one minute at 30 mi. per hr. under propulsion by an engine developing 12 HP. Their 1904 model is stated to weigh some 900 lbs. and with a 17-HP. engine ran 20 min. at 25 mi. per hr. The maximum record aloft of the 1905 model was 38 min. at 34 mi. per hr.

Santos Dumont not satisfied with his success with dirigible balloons turned his attention to aeroplane flyers. His arrangement seems to be two lateral sections like double-decked wings with a box-kite-like rudder attached to a long lever in front of the machine. A 50-HP. eight-cylinder gasoline engine drives a small screw propeller in the rear. The greatest flight obtained with this machine is stated to have been 300 yards.

Occasional press notices for a few months back have chronicled the experiments of Henry Farman in Paris. The latest report is that on Jan. 13 he made a circuit of about 1,300 meters and won the Deutsch-Archdeacon prize which was offered for the first "heavier-than-air" machine to cover a circular kilometer. It is stated that this aeroplane weighs about 300 lbs. A frame of ash and piano wire seems to be arranged much in the form of the Wright flyer in this country. A forward rudder like Santos Dumont's scheme is provided. An eight-cylinder, 50-HP., gasoline motor, weighing about 175 lbs., is used for propulsion. The final trial for the Deutsch-Archdeacon prize was held a few miles outside Paris in the presence of members of the French Aero Club, several noted aeronauts and about 500 spectators. It is stated that the machine sailed gracefully, about 30 ft. above the ground, at a speed of some 25 mi. per hr.

In passing some mention needs to be made of the experiments and apparatus of Dr. Alexander Graham Bell. His fundamental supporting unit is a two-winged cell formed by covering two sides of a tetrahedral frame which is formed by joining four equilateral triangles. These two supporting surfaces form a dihedral angle. Bell has sought to conduct his experiments with a machine that could be flown as a kite until its properties had been fully investigated when the cable could be replaced by a proper propelling mechanism. Instead of copying his smaller construction on a larger scale the larger machines are aggregations of the smaller units. With the tetrahedral winged cells it is claimed that this can be done so that there is no interference in utilizing the current of air produced by flight and the total supporting force exerted is the sum of the forces of the individual cells when acting alone. Bell's latest type is said to be built up of 3393 small cells, in the general form of a section of a tetrahedron about 46.5 ft. across the top, 36 ft. along the bottom and 10.5 ft. deep. A space is provided in the center for the motor and operator. A 20-HP. gasoline engine drives two solid screw propellers. The airship with motor is reported to weigh 220 lbs. As this machine was taken from the laboratory of the inventor in November, 1907, no reports of its behavior in flight have been published.

In this brief review it has been impossible to catalog all those persons who have aided in solving the problems of aerial flight; we have merely pointed out those efforts which for one reason or another have seemed most conspicuous and which may fairly be called mile-stones along the road.

There is a good deal of misconception as to the probable field for successful aerial navigation. To the lay mind anything is possible, and the "navies battling in the blue" appears a reasonable probability of the future. The engineer, however, realizes the inherent dangers and difficulties of any form of air navigation. No invention or ingenuity can neutralize the danger to a body poised in mid air and dependent only upon the supporting power of the air to save it from a disastrous fall to the earth. No invention or ingenuity can make safe the navigation of a medium subject to such commotions

*Engineering News, Jan. 31, 1891.

as hurricanes and tornadoes. By no possibility can carriage of freight or possengers through mid air compete with their carriage on the earth's surface.

The field, then, for aerial navigation is limited to military use and for sporting purposes. The former is doubtful; the latter is fairly certain. As regards the former, it will be recalled that military balloons have been in use for more than half a century; and that modern high-power, long-range guns have greatly limited the usefulness of such methods of observation. There is every reason to believe that the same thing will limit the usefulness of the military dirigible balloon or flying machine. As for the use of any form of aerial navigation for carrying messages, the development of wireless telegraphy and telephony appears to have blocked all prospect of success there.

The sporting field is therefore the real field at which the flying machine inventor is aiming. Already ballooning and driving dirigibles are among the most popular fads of the sporting set in Paris. Aside from this the imitation of the birds has fascinated thousands and millions of people to an extent that makes certain the search for a successful flying machine will go steadily on, even though there be no prospect of great commercial returns to the inventor.

LETTERS TO THE EDITOR.

A Caution to Engineers in Philadelphia and Vicinity.

Sir: An individual representing himself as Captain Pearson, of London, an officer in the British Artillery Service, has been systematically visiting members of engineering societies in this city, especially members of the American Society for Testing Materials, and appealing for aid. His "hard-luck story" takes the form variously of his having been burned out at a boarding house at Pensacola, a hotel in Jamestown, or having suffered shipwreck. He is a glib-tongued individual of spare build with a decided English accent. He is believed to be unworthy of credit or assistance.

Very truly yours,
Edgar Marburg,
Secretary-Treasurer, American Society for Testing Materials.

Philadelphia, Pa., Jan. 11, 1908.

A Long Term of Office for a City Engineer.

Sir: I have just received a letter from Thomas Murray, City Engineer of Davenport, Iowa, who was a student of mine in the year 1866, in which he says, "I forgot to mention that I was elected City Engineer for another term"—the fortieth time.

This is a compliment of which few can boast.

Respectfully,
W. Dalton Clark.

1437 North Fifth St., Springfield, Ill., Jan. 6, 1908.

[One of the stock arguments against municipal ownership and operation of public utilities is that the engineers and other experts employed will be changed with every change in local politics, and the services of competent men cannot therefore be secured. There are, perhaps, a very few engineers in railway service who can show as long a record of service with one corporation as that quoted above; but in these days of kaleidoscopic corporation changes, there are very few private corporations which have so long a record of organization as forty years.

Remarkable as is the record of Mr. Murray at Davenport, it is surpassed by a city surveyor of Salisbury, England, who held office for fifty years. He was then succeeded by his son, Mr. A. C. Botham, Assoc. M. Inst. C. E., who has now held the office for a considerable number of years. —Ed.]

New York Bay Pollution and the Oyster and Clam Industry.

Sir: The daily press of New York has recently given an outline of the report of the New York Bay Pollution Commission, the publication of which report is alleged to be held up on account of the failure of the Board of Estimate and Apportionment to appropriate $5,000 therefor.

Without discussing the question as to whether the City of New York and adjoining municipalities should immediately undertake the purification of the sewage from the Metropolitan District, one thing referred to in the report of the Pollution Commission impresses me most forcibly, and that is, if the conditions are as the report of the Commission states them, the Legislature of the State of New York should be called upon at once to prohibit the sale of oysters and clams taken from the polluted area. This should be done immediately, and action should not at all depend upon any contemplated purification of the sewage of the City of New York and vicinity; for, assuming that the wisdom and necessity of purifying the sewage of the Metropolitan District was admitted, ten years would elapse before the necessary legislation would be obtained and the other necessary steps taken to carry out this scheme in its entirety, and the harmful effect of the distribution and sale of polluted oysters be nullified.

If the conditions are as greatly in need of action as stated in the report of the Commission, the need will be still greater before ten years have elapsed.

The value of the oysters and clams taken from the area affected by the sewage of the Metropolitan District is not more than $750,000. This cannot yield to the planters a profit of more than 10%, or, in other words, the prohibition of the sale of clams and oysters from the affected area means a loss of $75,000, a sum inconsiderable when the extent of the imperilment is kept in mind.

Yours very truly,
Alexander Potter.

143 Liberty St., New York, Jan. 6, 1908.

Relative Efficiency of Steam Boilers at High and Low Pressure.

Sir: I am interested in generating steam at low pressure, for evaporating purposes, and would like your opinion, or references to printed matter, relating to the following questions:

Will a steam generator when operating at 5 lbs. pressure be more efficient than when operating at 150 lbs. pressure, or, in other words, will more heat units be derived from a given amount of fuel?

Will the temperature of flue gases be lowered when pressure of steam drops from 150 lbs. to 5 lbs.?

Will the rate of evaporation per square foot of heating surface be increased?

In each case it may be assumed that the feed-water temperature is the same, and that induced draft is used in order to maintain similar conditions in the furnace.

Yours truly, F. H. Nickle.

Trenton, Mich., Jan. 3, 1908.

[The water in a steam boiler at 5 lbs. pressure is at a temperature of 228°. In a boiler at 150 lbs. pressure it is 366°, or 138° hotter. With very slow passage of the gases over the heating surface, as in a house-heating boiler for example, there should be a considerable difference of temperature in the gases going up the chimney and consequent better efficiency of the low pressure boiler. With most boilers, however, the rate of passage of the gases is so rapid and their temperature is so high that the practical gain in efficiency by the lower pressure will be very small.

In a feed-water heater or economizer utilizing the heat from the flue gases, the advantage of the low pressure will be much more marked. The rate of heat transmission is in general proportional to the total difference of temperature. With furnaces gases at 1,500° this total difference will be 1,272° for the low pressure boiler and 1,134° for the high pressure boiler. In an economizer using gases at an average temperature of 500° this temperature difference will be 272° with 5 lbs. pressure inside the economizer and only 134° with 150 lbs. pressure inside.—Ed.]

Dust Explosions in American Coal Mines.

Sir: In your issue of Jan. 2, 1908, under the heading "Dust Explosions in American Coal Mines," Mr. J. L. Dixon's report to the "Pittsburg Dispatch" is very interesting as a startling example of sensationalism, clothed in a partial garb of truth, which to those not particularly familiar with coal mines, or to those who have given the question of mine explosions no particular thought may make the report seem reasonable. Allow me to quote from the report this statement:

That coal dust will and does explode with the most disastrous results is no longer questioned by intelligent mining men. Its explosive force, weight for weight, is said to be four times greater than that of gunpowder.

This sounds alarming, but let us investigate the facts. Can Mr. Dixon cite a dust explosion pure and simple; one that occurred in a mine absolutely free from marsh gas? If he can, then we will gladly use coal dust instead of black powder, for it is four times more powerful and can doubtless be had for the asking. Did Mr. Dixon ever try to explode a pile of coal dust, or, better yet, a small box which holds finely powdered coal well intermixed with air?

An explosion of marsh gas (CH_4) develops principally black damp (CO_2), watery vapor, and intense heat; suppose now a small pocket of marsh gas in the roof of a heading is ignited; very likely a local explosion results. Consider the same heading filled with coal dust and ignite the gas. What takes place? If the gas is present in sufficient quantity, it will generate enough heat to bring the particles of carbon to incandescence, thereby giving them power to change incombustible CO_2 to combustible CO while coincident therewith we have the generation of various hydrocarbons resulting from distillation of coal such as C_6 H_6, C_7 H_1, C_8 H_{10}, etc., all of which tend to augment the explosion and make its effect much more disastrous. Powdered charcoal when mixed with sulphur and saltpeter gives us a powerful explosive. Would Mr. Dixon call powdered charcoal a powerful and highly dangerous explosive?

I agree with Mr. Dixon when he says most explosions are the result of gas and dust combined, nevertheless he cannot call the dust in itself explosive, otherwise we would see many headframes and bins wrecked where coal crushers are operated by electric motors. I am in accord too with the recommendations for keeping the headings of a mine free from dust. However, it is a noticeable fact that Mr. Dixon's recommendations touch only upon the dust raised by electrically operated machines; very objectionable dust to be sure, but no more so than the dust raised by the compressed air machines.

"Bituminous."

Republic, Pa., Jan. 8, 1908.

[We would remind "Bituminous" of the disastrous explosions which have occurred in connection with the use of pulverized coal as a fuel for cement kilns; also of the terrific explosions, which years ago wrecked some of the enormous flour mills of Minneapolis. Candy factories have been destroyed from a similar cause. It is well established that any combustible dust floating in air in a confined space, if present in sufficient quantity, may give rise to an explosion. Even when the amount of dust in the air is insufficient for a true explosion, an initial flash and puff may occur sufficient to raise the dust which always accumulates in quantity wherever the dust is floating in the air. The increased amount of dust thus raised will generally produce a true explosion.

It is true that dust explosions in mines are frequently started by initial explosions or flashes of gas; but if we mistake not, the exhaustive experiments carried out in England and on the Continent many years ago, showed that dust could also be ignited by a blown-out shot.

As to the comparative possible explosive effect of coal dust and of gunpowder, the total energy of an explosive depends on the amount of heat units it contains. Part of the weight of gunpowder is due to the saltpeter, which is the oxidizing agent, while coal dust takes its oxygen from the air. Mr. Dixon did not say that coal dust was as easily ignited as is gunpowder.

As to Mr. Dixon's report being "sensational," we found nothing in it that was not in close agreement with well established facts and with the accepted practice of mining engineers abroad, where, as shown in our issue of Dec 26, fatalities in coal mines average one-third those in the United States.—Ed.]

Computing Overhaul from Borrow Pits.

Sir: In your issue of Jan. 2, under "Notes and Queries," I notice the following question: "Is there any exact method of finding overhaul where material is hauled from wide borrow pits into large embankments and hauled from a point in a borrow pit to a point in the embankment not opposite that where excavated?" This query could be made the text for an exceedingly long sermon.

There are so many conditions affecting a problem of this kind, which must be taken into consideration in determining an approximate amount of overhaul that exactness can hardly be expected. The actual manner of doing the work does not necessarily determine the rights of the parties to the contract, as in the case of an excavation for roadbed, hauled into an embankment, where specifications and custom have decided that nearest cut goes into nearest fill, although in practice, the contractor gets on the top of the cut, and places the highest layers, regardless of haul, into the nearest fill.

Unless the instructions of the engineer direct otherwise, it should be assumed that the nearest material in the borrow-pit goes into the embankment directly opposite. Any excess over the amount required for a definite height of embankment directly opposite, should be assumed to have been taken from a strip lying outside the area needed for the opposite embankment, and the haul should be calculated from one or more centers of mass in

the pit, following the route of travel to runways in the embankment, and thence, along the embankment, to the place of deposit.

If the width of borrow pit is such that the free haul does not cover it, all the material lying outside of a line parallel to roadbed at free haul distance, is entitled to overhaul, although it is deposited in embankment directly opposite. The measurement for overhaul in this case, should be from centers of mass, along routes of travel to runways, and thence to place of deposit; this overhaul volume being assumed to be used in making a certain depth of the top of the embankment. In other words, it should be assumed that the free haul material will build the embankment to a certain height as determined by the relative volumes in pit and bank.

The appliances used in performing the work, and the character of the material, have a bearing in the matter. The foregoing assumes that the larger part of the material in the pit goes directly opposite into embankment; that the haul endwise is not excessive for wheeled scrapers or dump wagons, and that the material is suitable for handling with such excavators as scrapers or grading machines. When the amount of material required, its character and the distance it is to be transported, are such that, in the judgment of the contractor and with the concurrence of the engineer, cars and track are most adaptable for the work, and such appliances are used, the overhaul distance should be determined by the actual travel, or the distance required to be traveled, on grades suitable for the motive power, whether horses, engines or hoisting engines. When the building of the bank directly opposite is done by the same means, there are many good reasons why the travel distance should apply, and overhaul should be allowed. The expense in changing plant, convenience in shaping the pit, and the character of the material should be considered as affecting economical execution.

The occasion for the big burrow-pit, or the purpose it may serve, is to be considered. Is the right-of-way at other places unsuitable or difficult to obtain, thereby depriving the contractor from having cheap side work? Is the pit to become a river channel diversion, thereby causing the contractor to go to unusual depths in carrying out the purpose? Did the exhibits at the letting of the work disclose this intention so that the contractor could equate this higher priced work in making his average? It seems as if there should be some flexibility in calculations for overhaul, which would, in a measure, compensate the contractor for extra expenses thrown upon him in unforeseen situations, developed by the necessities or conveniences of the other party.

Overhaul as sometimes provided for in contracts, could drive a contractor into shaft excavation, at one cent per yard per 100 ft. for hoisting. No one expects this to be done, but when a specification provides for hauling excavations for roadbed, from above grade line, into embankment below grade line, with an overhaul price, it puts a burden upon the contractor to find that the excavations, at places, are located many feet below grade line, and air line distances are used in calculating his overhaul. It is not an excess of liability on the part of the engineer to make the road easy to travel in measuring the distance for overhaul.

Exact methods in solving problems, and exact fairness in the result, do not always agree, and engineers do well to consider both propositions.

A. C. E.

Chicago, Jan. 4, 1908.

Notes and Queries.

Mr. H. E. J., of Keokee, Va., wishes to know of methods for cleaning rusty nails so they may be used again.

In the "Railway Location Problem" given in our issue of Jan. 9, p. 41, a typographical error occurred. The seventh line should read "In triangle AOK, find ∠AOK, ∠AKO and OK" instead of "In triangle OMH, find ∠MOH, ∠KOH = ∠MOH − ∠AOK." This latter sentence is a later part of the solution and was given in the ninth line.

STANDARD SPECIFICATIONS FOR CONCRETE HOLLOW BLOCKS.

The Committee on Standard Specifications of the National Association of Cement Users has prepared, through its chairman, Mr. E. S. Larned, a set of Standard Specifications for Concrete Hollow Blocks which will be presented before the annual convention of the Association at Buffalo, Jan. 20-25, and if there adopted will be suggested for use to all the building commissions in the various cities of the country. We publish below some of the more important clauses so that engineers interested may be able to forward to Buffalo any criticism that would help the association in adopting the specifications. The portions not here printed apply for the most part to general qualities of cement and stone which are already cared for in other specifications.

PROPORTIONS.—For Exposed Exterior or Bearing Walls: (a) Concrete hollow blocks, machine made, using a semi-wet concrete or mortar, shall contain one part cement to, not to exceed, three parts sand and four parts stone. When the stone is omitted, the proportion of sand shall not be increased.

(b) When said blocks are made of slush concrete, in individual molds and allowed to harden undisturbed in same before removal, the proportions may be one part cement to, not to exceed, three parts sand and five parts stone, but in this case also, if the stone be omitted the proportion of sand shall not be increased.

When less sand or less stone, than in clauses (a) and (b) be used to produce special blocks, the ratio of sand to stone shall not be less than 0.50.

MOLDING.—Due care shall be used to secure density and uniformity in the blocks by tamping or other suitable means of compression. Tamped blocks shall not be finished by simply striking off with a straight edge, but, after striking off, the top surfaces shall be trowelled or otherwise finished to secure density and a sharp and true arris.

CURING.—Every precaution shall be taken to prevent the drying out of the blocks during their initial set and first hardening. A sufficiency of water shall first be used in the mixing to perfect the crystallization of the cement, and, after molding, the blocks shall be carefuly protected from wind-currents, sunlight, dry heat or freezing, for at least five days, during which time additional moisture shall be supplied by approved methods, and occasionally thereafter until ready for use.

AGEING.—Concrete hollow blocks in which the ratio of cement to sand be one-third (one part cement to three parts sand), shall not be used in the construction of any building until they have attained the age of at least three weeks.

Concrete hollow blocks in which the ratio of cement to sand be one-half (one part cement to two parts sand) may be used in construction at the age of two weeks, with the special consent of the Bureau of Building Inspection and the architect or engineer in charge.

Special blocks of rich composition, required for closures may be used at the age of seven days with the special consent of the same authorities.

The time herein named, is conditional, however, upon maintaining proper conditions of exposure during the curing period.

THICKNESS OF WALLS.—The thickness of bearing walls for any building where concrete hollow blocks are used, may be 10% less than is required by law for brick walls. For curtain walls, or partition walls the requirements shall be the same as in the use of hollow tile, terra cotta or plaster blocks.

PARTY WALLS.—Hollow concrete blocks shall not be permitted in the construction of party walls, said walls must be built solid.

LAYING OF WALLS.—Where the face only is of hollow concrete block, and the backing is of brick, the facing of hollow block must be strongly bonded to the brick either with headers projecting four inches into the brick, every fourth course being a heading course, or with approved ties; no brick backing to be less than 8 ins. Where the walls are made entirely of concrete blocks, but where said blocks have not the same width as the wall, every fifth course shall extend through the wall, forming a secure bond. All walls, where blocks are used, shall be laid up with Portland cement mortar.

GIRDERS OR JOISTS.—Wherever girders or joists rest upon walls so that there is a concentrated load on the block of over two tons, the blocks supporting the girder or joists must be made solid for at least 8 ins. from the inside face. Where such concentrated load shall exceed five tons, the blocks for at least three courses below, and for a distance extending at least 18 ins. each side of said girder, shall be made solid for at least 8 ins. from the inside face. Wherever walls are decreased in thickness, the top course of the thicker wall shall afford a full solid bearing for the webs or walls of the course of blocks above.

LIMIT OF LOADING.—No wall, nor any part thereof, composed of concrete hollow blocks, shall be loaded to an excess of eight tons per superficial foot of the area of such blocks, including the weight of the wall, and no blocks shall be used in bearing walls that have an average crushing at less than 1,000 lbs. per sq. in. of area, at the age of 28 days; no deduction to be made in figuring the area for the hollow spaces.

SILLS AND LINTELS.—Concrete sills and lintels shall be reinforced by iron or steel rods in a manner satisfactory to the Bureau of Building Inspection, or the architect or engineer in charge, and any lintels spanning over 4 ft. 6 ins. shall rest on blocks solid for at least 8 ins. from the face next the opening and for at least three courses below the bottom of the lintel.

HOLLOW SPACE.—The hollow space in building blocks, used in bearing walls, shall not exceed the percentage given in the following table for different height walls, and in no case shall the walls or webs of the block be less in thickness than one-fourth their height. The figures given in the table represent the percentage of such hollow space for different height walls.

Stories.	1st	2nd	3rd	4th	5th	6th
1 and 2.	33	33				
3 and 4.	25	33	33	33		
5 and 6.	20	25	25	33	33	33

TEST REQUIREMENTS.—Concrete hollow blocks must be subjected to the following tests: Transverse, compression and absorption, and may be subjected to the freezing and fire tests, but the expense of conducting the freezing and fire tests will not be imposed upon the manufacturer of said blocks.

The test samples must represent the ordinary commercial product, of the regular size and shape used in construction. The samples may be tested as soon as desired by the applicant, but in no case later than sixty days after manufacture.

TRANSVERSE TEST.—The modulus of rupture for concrete blocks at 28 days must average 150, and must not fall below 100 in any case.

COMPRESSION TEST.—The ultimate compressive strength at 28 days must average 1,000 lbs per sq. in., and must not fall below 700 in any case.

ABSORPTION TEST.—The percentage of absorption (being the weight of water absorbed, divided by the weight of the dry sample) must not average higher than 15%, and must not exceed 22% in any case.

CEMENT BRICK.—Cement brick may be used as a substitute for clay brick. They shall be made of one part cement to not exceeding four parts clean sharp sand, or one part cement to not exceeding three parts clean sharp sand and three parts broken stone or gravel passing the ½-in. and refused by the ¼-in. mesh sieve. In all other respects, cement brick must conform to the requirements of the foregoing specifications.

AN UNIQUE DIRECT-READING DYNAMOMETER FOR TESTING AUTOMOBILES.

Testing apparatus of unusual interest to engineers has been recently placed in operation in the building of the Automobile Club of America on West 54th St., New York City. This is, in brief, an indicating dynamometer which shows directly to the observers what speed, tractive effort, HP. and grade climbing ability the automobile under test is developing at any instant. By additional tests the friction losses in the driving mechanism, the holding power of the brakes and the accuracy of the speed-indicators on the machinery may be conveniently and quickly determined. It is obvious that this must be one of the most complete arrangements of testing apparatus extant. However, the machinery does not seem excessively complicated, is capable of comparatively readily accurate calibration, and should be operated by a competent mechanician. It is expected that this dynamometer will find considerable service for purchasers and manufacturers in making tests under more favorable conditions than would be ordinarily secured on the road, especially as to rights-of-way for speeding.

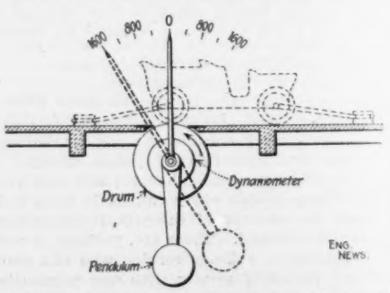


Fig. 1. Diagrammatic Arrangement of Automobile Dynamometer, Showing Pendulum of Tractive Effort Indicator.

In 1904 Dr. Schuyler Skaats Wheeler, Past Pres. Am. Inst. E. E., First Vice-President of the Automobile Club of America, and President of the Crocker-Wheeler Co., was authorized to invent, design and construct such a dynamometer as this. The resultant apparatus represents then several years' attention to the problem by Dr. Wheeler and by several engineers connected with the Crocker-Wheeler Co.

It should be stated that the power indications of this dynamometer are true for driving-wheels of the automobile at the tire tread, thus showing the net performance of the car. The car is

held stationary, by cables, with the forward wheels on the floor and the driving-wheels on two large paper pulleys or drums which just come through the floor. The drums are mounted on a shaft which also carries the disks of an Alden absorption-dynamometer brake.

Ordinarily this type of dynamometer is made up of seven general parts: one or more smooth circular, cast-iron disks keyed to the shaft which transmits the HP. to be measured; a housing revolving through a limited length of arc and having bearings on the hub of the revolving disks; a system of thin copper plates fastened to the housing, one face of each plate being close and parallel to one face of a disk, the other face with the housing forming a pressure chamber; a system of oil circulation by which the friction surfaces of copper and cast iron are kept well lubricated; a system of water circulation such that a flow, under pressure, is maintained through the pressure chambers; automatic and manually-operated valves for regulating the quantity and pressure of the cooling waters; a means of balancing and indicating the torque developed. This dynamometer brake and its special applications have been described in previous issues of this journal (in Engineering News June 28, 1890, and May 19, 1904).

In this particular adaptation of the Alden brake a few changes from the usual construction were found advisable. For testing light HP. cars the double disk apparatus was too heavy to secure the light load desired, though both disks were necessary for testing the larger cars. One disk then was arranged so that it could be attached to or disconnected from the main shaft by a small clutch as shown in Fig. 4. Instead of weighing the torque as is customary a balance is automatically obtained by the deflection of a 500-lb. pendulum. When both friction disks are used the weight of the pendulum is increased by auxiliary weight to 1,600 lbs. The shaft which bears this pendulum carries on one end the brake casing and on the other end a pointer extending upward and sweeping through an arc of 30° over a proper scale. The torque developed is proportional to the deflection of the pendulum and the scale showing the deflection may be

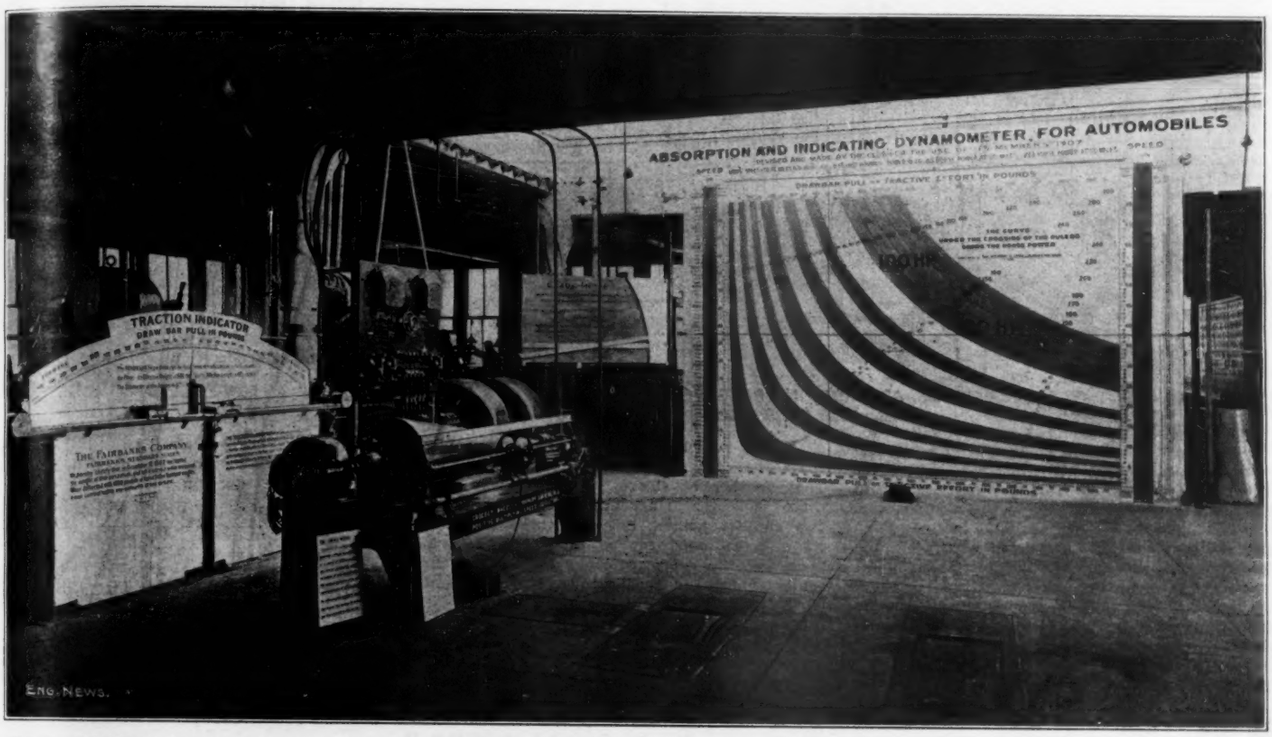


FIG. 2. GENERAL ARRANGEMENT OF INDICATING APPARATUS USED WITH ABSORPTION DYNAMOMETER FOR MEASURING THE PERFORMANCE OF AUTOMOBILES. INSTALLED AT CLUB HOUSE OF AUTOMOBILE CLUB OF AMERICA.

FIG. 3. GENERAL ARRANGEMENT OF TRACK DRUMS, ABSORPTION BRAKE, PENDULUM DYNAMOMETER, SHAFT-DRIVING MOTOR AND CLUTCHES, ON FLOOR BELOW INDICATING APPARATUS.

graduated so as to read directly the draw-bar pull or tractive effort of the automobile.

The Fairbanks Co., makers of the Fairbanks Standard Scales, calibrated this pendulum by hanging standard weights from the periphery of the large drums. In addition to the rigid traction-indicator pointer (Fig. 4) there is provided a smaller one, made somewhat elastic by springs, which works such contacts that a motor-operated follower-carriage moves across the scale as shown at the left in Fig. 2. This carriage travel is transmitted to the vertical rule which moves across the face of the large HP. chart.

ment of centrifugally operated contacts such that, when the speed of the cone begins to drop, a portion of the field current of the cone driving motor is by-passed through resistance. This tends to increase the speed of the motor and of the cone. As the speed begins to rise above the desired critical point the auxiliary shunt resistance circuit is opened and full field current is restored. This increase of field current tends to decrease the speed. A bell attached to the cone rings at every 100 revolutions, or every 30 secs. A wheel or disk, in contact with the conical surface, is arranged to revolve freely on

less than that of the disk the contact point of the latter will remain against the rear contact of the revolving arm, and if the peripheral velocity of the cone should be more than that of the disk, then the disk contact is held against the forward contact. When these contacts are so made the feathered sleeve is moved along the splined shaft, in the proper direction, by an auxiliary motor-drive until a point is reached where the peripheral velocities balance. The back motion of the wheel carriage is transmitted by small cables to the horizontal ruler moving up the face of the large HP. curve chart. This

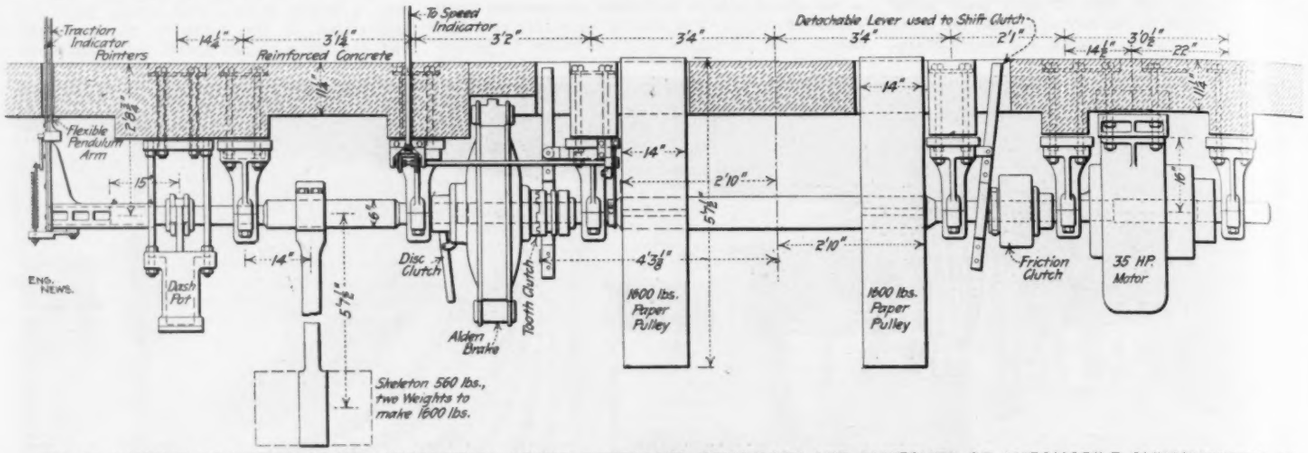


FIG. 4. LAYOUT OF MOTOR DRUMS, ABSORPTION BRAKE, PENDULUM, DASH POTS AND CLUTCHES OF AUTOMOBILE DYNAMOMETER AT THE CLUB HOUSE OF AUTOMOBILE CLUB OF AMERICA.

There are provided two carriages, one for forward motion of the automobile wheels and the other for reverse. When one carriage is in operation the other is locked at the zero position.

Some difficulty was encountered in finding an apparatus capable of measuring accurately the speed of the car, and of transmitting such indication to the horizontal rule of the large chart without deriving power from the automobile driving-wheels in more than negligible amounts and without impairing the accuracy of the tractive-effort readings. In the machine designed to meet these needs a large horizontal cone is revolved at constant speed (200 r. p. m. within 0.5%) by a shunt-wound motor with a timing governor. This governor is in effect an arrange-

a sleeve which is feathered to a splined shaft parallel to an element of the cone. The feathered sleeve also carries rigidly three collector rings and an arm having two contact points. Between these two points plays a contact arm of the loose disk. The three collector rings are connected to these three contact points, and by brushes proper connection is maintained with the control circuits. The splined shaft is driven by gears from the shaft bearing the drums on which the driving-wheels of the automobile press. It is obvious that unless the peripheral velocities of the wheel and cone at the point of contact are identical there will be some slip. If the peripheral velocity of the conical surface at the point of contact is

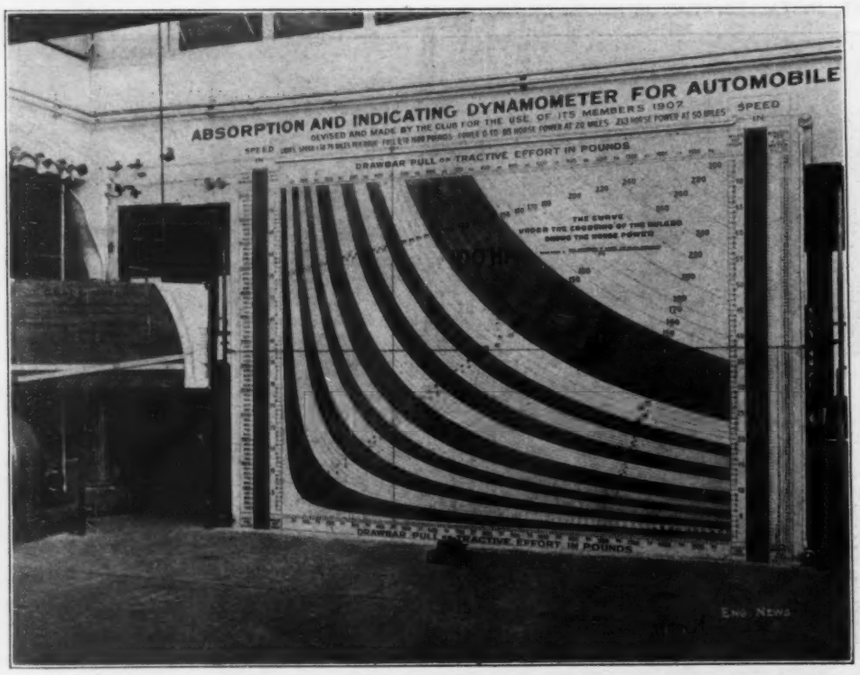

ABSORPTION AND INDICATING DYNAMOMETER FOR AUTOMOBILE
DEVISED AND MADE BY THE CLUB FOR THE USE OF ITS MEMBERS 1907
SPEED
DRAWBAR PULL = TRACTIVE EFFORT IN POUNDS
DRAWBAR PULL = TRACTIVE EFFORT IN POUNDS
ENG. NEWS

FIG. 5. HORSE-POWER CHART AND GRADE METER OF AUTOMOBILE DYNAMOMETER.

chart has 79 curves plotted, as is seen between lbs. tractive effort and mi. per hour, to show values of the equation

$$HP. = \frac{\text{pull (lbs.)} \times \text{speed (mi. per hr.)}}{375}$$

from 0.1 to 300 HP. From Fig. 5 it is evident that the size of the curve chart is such that the observations may be read by the driver of the car. It is seen that speed may be read in mi. per hr., ft. per min., min. per mi., kilometers per hr., and min. per kilometer.

All the apparatus is reversible, so that the performance of the car may be determined for running backwards.

There is also provided a grade meter, operated from the tractive-effort indicator, showing graphically the equation

$$\text{Sine angle of grade} = \frac{\text{tractive effort}}{\text{weight of car}}$$

$$\text{Grade} = 100 \times \tan.\ \text{angle of grade} = \frac{100\ T^2}{(W^2 - T^2)^{\frac{1}{2}}}$$

This is evident from Fig. 6, which somewhat diagrammatically represents the grade-meter. The niche on the weight bar, which engages the horizontal bar operated from the dynamometer indicator, is set at the point representing the weight of the car. The pointer on this weight bar then indicates at each moment the grade the car would climb, neglecting wind resistance, slippage, etc.

When a car is under test the large duct seen raised to the ceiling in Fig. 2 is lowered and temporary connections made to the exhaust of the engine. A motor-driven fan carries away the smoke and gases.

It will be noted from Fig. 4 that an electric motor is provided so that it may be connected to the shaft of the track drums. With this arrangement the condition of an automobile coasting may be duplicated. By measuring the additional input to this motor, for these coasting tests, the holding power of the brakes and the friction losses of the car machinery may be calculated. By placing the front wheels of the car on the drums and revolving them, by means of the motor, the speedometer may be calibrated. In all tests using the driving motor the absorp-

tion dynamometer itself is disconnected from the drums by throwing out a tooth-clutch, shown in Fig. 4.

To develop, construct and install this dynamometer, the expense to the Automobile Club has been about $10,000. The expense of duplicating the arrangement would, of course, be that figure less the development and pattern costs.

AN ANALYSIS OF THE FIRE IN THE PARKER BUILDING, NEW YORK CITY.

By PETER JOSEPH McKEON.*

The subject of fire in "fireproof" buildings is once more raised by the fire in the Parker Building at 4th Ave. and 19th St., New York City, on Jan. 10, 1908. The results of this fire were not unexpected by fire engineers, who are familiar with the fire conditions of the large buildings in New York City. Surprising as this fire appears to the layman, it is a reasonable prophecy to state that it will be greatly exceeded if a similar building takes fire, which contains a greater mass of combustible material. There are many such buildings in New York, particularly in the Broadway mercantile district, and in the printing district in the vicinity of the Brooklyn Bridge.

CONSTRUCTION AND OCCUPANCY.—The Parker Building is 12 stories, or 165 ft. high, an average of nearly 14 ft. per floor. In area it is about 17,000 sq. ft. The floor construction is hollow tile (terra cotta) arches between steel beams, carried on cast-iron columns, and the beams, girders, and columns are fireproofed with the same material. The floors are of wood, laid on wood sleepers, which are filled in with concrete.

The floor openings comprise two sets of stairs and elevators, which are unenclosed and open to the floors except for hall partitions, which are partly terra cotta blocks and partly wood doors and plain glass. The fire appliances consisted of fire pails, a 2½-in. standpipe, with hose connections and a fire pump, one Special Building Signal box, and a watchman. The occupancy was mixed mercantile and manufacturing, such as stocks of books, rugs, woolens, and furniture, with a number of printers.

COURSE OF THE FIRE.—The fire appears to have started at some time after 6 p. m., and was undoubtedly burning for a considerable time before discovery. People in the vicinity, notably, the superintendent of The American Lithographing Co., had smelled smoke for some time, while the watchman is also reported to have smelled smoke, long before the fire discovered itself. This is not surprising, because a building of this construction confines smoke and heat rather

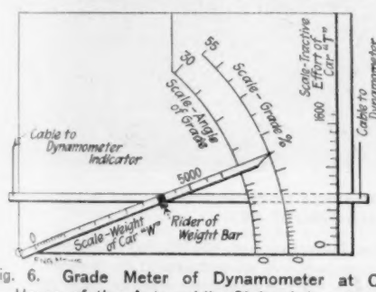


Fig. 6. Grade Meter of Dynamometer at Club House of the Automobile Club of America.

tightly, and the iron shutters on the rear of the building also helped to hide the fire.

At 8 o'clock, the watchman verified the presence of the fire and gave the alarm. The Fire Department responded promptly, and located the fire on the 6th floor, in the premises of The Detmer Woolen Co., toward the rear of the building, and close to the rear elevators. The Insurance Patrolmen (Salvage Corps) entered the 5th floor, to spread waterproof covers, and found that the fire was on this floor also. The firemen stretched hose and fought the fire for a time, but were quickly driven from the 6th and 5th floors. The fire then extended unhindered to the upper floors of the building, partly by way of the windows, but principally through the elevator and stair shafts. At first, it was confined to the rear portion of the building, but after an hour, it extended to the front of the building on the seven upper floors and showed on the 4th Ave. side.

This took place about 9:30 p. m., one hour and a half after the Fire Department arrived. A few minutes later a collapse occurred, caused by a cylinder press falling from the 11th floor to the basement, unfortunately causing the death of three men, injuring a dozen more, and imperiling nearly fifty. In the collapse, burning debris was carried down to the basement. In the demoralization following the collapse, little effort could be made to fight the fire, which quickly burned from the basement to the 5th floor and thus completed the gutting of the entire building.

CONCLUSIONS.—From the preceding analysis, based on information as reliable as can be obtained, short of an official investigation, what conclusions can be drawn?

1. That the fire gained considerable headway through the absence of an automatic alarm or efficient watchman service. The watchman did not enter all the floors of the building, and was not under supervision to make sure that he patrolled the building regularly.

2. That the construction, per se, was good, but the plan and design of the building were faulty. Any building that will stand such a severe fire test for 90 minutes, without serious collapse is certainly fairly well built, and reasonably fire resistant. If fire in such a building can not be conquered within an hour, the trouble is not with the type of construction, but with other factors, such as the plan and design, the absence of fire extinguishing appliances, or the Fire Department.

3. That the plan and design of the building was faulty, partly in the large area without fire stops, but principally in the unenclosed stairs and elevators. This latter defect permitted the fire to get a firm hold on two floors before it was discovered, and thereafter, was the principal cause for the spreading of the fire throughout the building. The large undivided area not only favored the spread of the fire in a horizontal direction, but it also meant an accumulation of heat and smoke that could not be endured by even the very best firemen.

4. That after the first fifteen minutes, the building was doomed. When the firemen were driven off the 6th and 5th floors, there was no possible way of stopping the fire and for humanitarian reasons, the men might as well have walked out of the building.

As inside hose streams could not be used, the only thing left was outside streams. At the 5th and 6th floors, which are about 75 ft. above the street, the water tower and street streams are practically useless. This was fully demonstrated, inasmuch as the water did little more than reach the windows. Once the nozzle of the water tower is pointed above the horizontal, the angle of incidence of the stream prevents water entering the building more than a few feet from the windows. The same thing is true, to a greater extent, of streams directed from nozzles at the street level. The attempt to pump water to the top floor of the American Lithograph Company's building, 11 stories high, and then direct it across Fourth Avenue, a horizontal distance of 100 feet, was a surprising exhibition by the New York Fire Department.

The only vantage point left to the firemen was the Florence Hotel adjoining; but even effective streams from this building would only have covered the south-east corner of the Parker Building.

5. That the absence of fire escapes prevented the Fire Department from attempting to fight the fire after the men were driven off the 5th and 6th floors. Fire escapes are usually intended as a means of egress for the occupants, but they are also a valuable aid to the firemen.

6. That the factors of hose and water supply were of little moment. If the newspaper statements about rotten hose and poor water are official, it is a cause for surprise. Bursting hose is an accompaniment of every fire, and it is almost impossible to eliminate it. No matter how well made the hose is, it receives such hard usage that a certain amount of burst hose must always be expected.

In respect to the water supply there were available both the regular low pressure mains and the high pressure mains, on Broadway, which had the Croton pressure. The use of these two sets of mains provided more hydrants and more water than were ever before available at a fire in New York City.

7. That the high pressure system would have made little or no difference in fighting the fire. The building is really out of the high pressure zone, the eastern boundary of which is Broadway, at this point. Even if the high pressure system had been in operation and delivered water at the hydrant nozzles under a pressure of 235 lbs., the loss through the long stretches of hose would have reduced the pressure by 50 lbs. or more, so that the pressure available would have been no better than that provided by the fire engines, as these can maintain an average working pressure of 200 lbs.

8. That the installation of an automatic sprinkler equipment would have undoubtedly prevented the sweeping course of the fire. The sprinklers would have announced the fire at its start, and unquestionably extinguished or checked it, or even if it extended, the firemen could have distributed water over the entire fire area without entering the building. The cost of such an equipment would not have been more than a few thousand dollars, and it would unquestionably have prevented this property damage, which certainly runs into millions of dollars.

Since the above contribution was in type, we have learned from authentic sources that the *lower flanges of the steel girders and floor beams of the Parker Building were unprotected by fireproofing.* The flat terra-cotta arches extended simply from beam to beam with no projections to cover the lower flanges. These were shielded from the heat, therefore, only by the plaster, which soon cracked off. We are also informed that there were numerous wooden partitions in the building, erected to subdivide space for the convenience of tenants.—Ed. Eng. News.

*Editor "The Journal of Fire," 25 W. 42d St., New York City.

PROPOSED AUXILIARY WATER SYSTEM FOR FIRE PROTECTION AND FLUSHING PURPOSES, SAN FRANCISCO, CAL.

Plans and estimates for an auxiliary water system for San Francisco have been made by Mr. Thos. P. Woodward, City Engineer, assisted and advised by Mr. T. W. Ransom, Consulting Mechanical Engineer. The primary object of the system is fire protection, with special reference to earthquake contingencies, but provision has been made for water for flushing and like purposes. The estimated cost of the proposed water system is $5,500,000. A bond election will probably be held in April or May, 1908, to permit a popular vote on the subject. Pending the appearance of a printed report, Mr. Woodward has kindly sent us an outline of the scheme, the substance of which follows:

The area to be protected, about 4,100 acres, was determined upon after consultation with the Chief of the Fire Department, the Secretary of the Merchants' Association, and a number of the local representatives of the insurance companies.

The system, as at present outlined, will consist of a network of pipes in two zones, two fresh-water reservoirs for supplying water under ordinary conditions, two distributing systems, two auxiliary salt-water pumping stations, located on the water front, for use in the event of a general conflagration, two fire boats, a number of cisterns located at points of vantage in the residence and business districts, and an independent telephone service for the sole use of the fire department.

The two storage reservoirs, each having a capacity of 5,000,000 gals., are to be located on Twin Peaks, in the vicinity of the intersection of 20th and Cole Sts., at an elevation of 755 ft. The capacity of these reservoirs will be equal in amount to the continuous delivery of 20 of the city's ordinary steam fire engines for about 16 hours. From the reservoirs the water will flow through two 20-in. pipes, each of which will traverse a different route, to the distributing reservoir of the upper zone, located in the vicinity of 17th and Ashbury Sts., which will have a capacity of 600,000 gals. This reser-

voir will be connected with the distributing reservoir of the lower zone, which will be constructed in Jones St., between Sacramento and Clay Streets. Its capacity will be 1,000,000 gals.

These reservoirs will keep the mains in each zone filled [with fresh water] under a moderate pressure and will serve for all ordinary fires. A fire-engine house will be located in the vicinity of each, with men on duty at all times who will turn on the high pressure when called for.

The distributing system of each zone will consist of a network of cast-iron pipes, interconnected so as to obtain as perfect a circulation as possible, together with the necessary valves and hydrants, and a number of fire-boat connections. The hydrants are to be so placed that 15,000 gals. per min. can be concentrated on an area in the old congested-value district of 100,000 sq. ft. In the other portions of the protected district the amount that can be concentrated on any block varies from 8,000 to 12,000 gals. per min. The gates or shut-off valves are so arranged that any one block may be cut off for the purpose of making repairs or inspection without affecting the hydrants in any other blocks.

From the experience gained in the earthquake of April 18, 1906, it is possible to state that an earthquake of equal intensity will not seriously affect distribution pipes properly laid on solid ground, and that it is doubtful whether it is possible to construct pipe-lines in such a manner that they will not be apt to be rendered useless in ground that is liable to suffer serious displacement because of earthquake shock. In the proposed system none of the main pipes will be laid in the streets in the portions of the city liable to disturbance by earthquake, and in addition to using every precaution in laying the smaller pipes in these streets, it is proposed to so arrange the system that by closing not over five gate valves, all of the portions of the system constructed in these districts can be cut off, thus minimizing the danger of an earthquake disabling the entire system by breaking a large number of pipes in a comparatively small area.

The salt-water pumping-plants will be two in number, one situated near the foot of Second St. and the other near the foot of Van Ness Ave. or Polk St. Each station will be of sufficient size to provide for the installation of machinery to pump 16,000 gals. per min. against a pressure of 300 lbs. per sq. in., together with quarters for the men necessary for its operation. For the present, it is proposed to install at each station sufficient mechanical equipment to pump 10,000 gals. per min. against a pressure of 300 lbs. per sq. in. They will be located on foundations of solid rock. Every precaution will be taken to make them earthquake proof, as well as fire proof, and they will be so interconnected by pipes laid in solid ground that the destruction of an entire station will not seriously affect the usefulness of such parts of the system as may remain intact.

In addition, it is proposed to provide at least two fire boats, each having a capacity of 8,000 gals. per min. against a pressure of 150 lbs. per sq. in., or 4,000 gals. per min. against a pressure of 300 lbs. per sq. in. Under ordinary circumstances these boats will be used for the protection of shipping and wharves in the port of San Francisco, but in case an earthquake should result in the destruction of part of the piping system, they will be available to pump into other parts of the system through connections provided on the water front or hose-lines run into the city, as circumstances may determine.

The 50 existing fire cisterns are to be repaired and placed in use, and 100 new ones, ranging in capacity from 25,000 to 100,000 gals., are recommended for immediate construction. These cisterns, which will be built of reinforced concrete, are to be so located that they will offer a maximum protection to filled-in areas and localities where the distribution system is most liable to injury.

The telephone system will be so designed that a fire in any part of the protected district can be observed from at least one call station, and orders regarding the pressure required may be transmitted to the engineers at the pumping-station or the gateman at the pressure relief tank.

THE NEW HOUSE OF THE ENGINEERS' CLUB OF PHILADELPHIA.

On Saturday evening, Jan. 11, the Engineers' Club of Philadelphia celebrated the 30th anniversary of its establishment, with a reception and housewarming in its new home at 1317 Spruce St. A thousand invitations were sent out and the clubhouse was filled during the entire evening. As many of our readers know, the club has long had a house at 1122 Girard St., but with the growth of the club in membership during recent years a demand arose for larger and more comfortable quarters.

The house just purchased was formerly the residence of the late Charles W. Potts, wealthy Philadelphia iron merchant. It is of recent construction and lends itself admirably to use as a clubhouse. On the first floor are two spacious parlors connected by a broad archway, with a hall at the side leading to the stairway and to a large dining room at the rear occupying the entire width of the building.

In the basement are lavatories, toilet rooms and coat rooms. The meeting hall is on the second floor. A view looking toward the desk of the presiding officer is shown herewith. All seats and furniture are movable, making the entire floor space available for use at social functions. The rear of this floor is devoted to library and reading rooms. Sleeping rooms for the use of club members are on the upper floors. The entire house with its new furnishings and equipment throughout represents an investment in the neighborhood of $100,000, which speaks eloquently of the interest taken in the club by its members and the energy of its officers.

The Engineers' Club of Phidalephia was organized in 1878. Prominent among those who took part in its foundation was the late Dr. Coleman Sellers. By reference to Engineering News of March 21, 1878, we find it noted that "recent meetings of the Engineers' Club of Philadelphia have been especially interesting." The volume for that year contains nearly a dozen reports of the club's meetings and the names of many are recorded as taking part in the discussions who are still active in engineering work in Philadelphia.

In its early years the club's chief function was the reading and discussion of technical papers; but later the importance of the social features of the club was fully recognized and ever since the club has had a house of its own it has been a gathering place and social center for engineers. With the new and attractive clubhouse the club will doubtless prove still more attractive to engineers resident in Philadelphia.

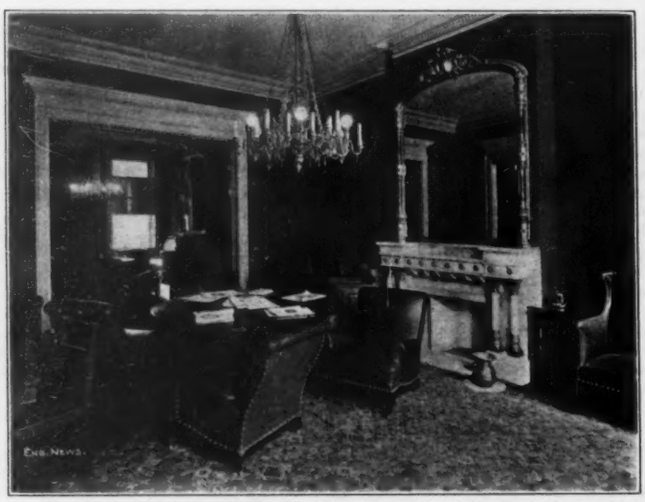
The officers of the club who have served during the past year are as follows: President, Henry H. Quimby; vice-presidents, Washington Devereaux, W. P. Dallett; secretary, Walter Goring Webb; treasurer, George T. Gwilliam; directors, F. E. Dodge, William Easby, Jr., Francis Head, John T. Loomis, J. W. Ledoux, Emile G. Perrot.

At the annual meeting to be held on Jan. 18, officers for the ensuing year are to be elected and the nominating committee has presented the following ticket: President, Professor H. W. Spangler; vice-presidents, Washington Devereaux, W. P. Dallett, William Easby, Jr.; secretary, Francis Head; treasurer, George T. Gwilliam; directors, John T. Loomis, J. W. Ledoux, Emile G. Perrot, F. E. Dodge, J. O. Clarke, H. G. Perring, Henry H. Quimby, William S. Twining, James Christie, H. P. Cochrane, Richard C. Develin, Henry Hess.

MANUFACTURED ICE IN THE UNITED STATES.

A portion of Bulletin 83, just issued by the U. S. Bureau of the Census, contains an interesting statistical and historical exhibit of the manufacture of ice. The statistical portion, in general summary, extends back to 1870, but the detail figures by States are for the years 1905 and 1900, only.

According to the bulletin, artificial ice plants have increased from 4 in 1870, with a capital investment of $434,000, to 1,320 in 1905, with a total investment of $66,592,000. The statistics do not include ice manufactured in breweries, cold-storage warehouses, etc.; that is, they show only ice produced for sale. It is stated that in 1870 "ice was worth from $20 to $30 a ton, while in 1905 the average value was $3.12" per ton. Ice-producing plants were reported in 37 States in 1900 and in 41 in 1905—the States added to the list being Massachusetts, Wisconsin, Idaho and Nevada. As might be expected, "in proportion to the population the Southern States had a much larger number of ice-manufacturing plants than the Northern and Western States." The States of Maine, New Hampshire, Vermont, Michigan, Minnesota, North Dakota, South Dakota, Montana and Wyoming report no ice plants. A map showing the northern limit of manufactured ice, as reported, in 1905 is so interesting that we reproduce it herewith. It will be observed that for the most part the ice-plant limit is some distance north of the isothermal line for 32° F., as ob-



A Corner in the Parlor.

Hall for Meetings on Second Floor.

THE NEW HOUSE OF THE ENGINEERS' CLUB OF PHILADELPHIA AT 1317 SPRUCE ST.

served in January, 1904, by the U. S. Weather Bureau. The map is also interesting as showing the number of ice plants in each State.

A small table, reproduced herewith, gives the kind, quantity and value of ice for the years 1905 and 1900.

ICE MANUFACTURED, BY KIND, QUANTITY, AND VALUE, WITH PER CENT. OF INCREASE: 1905 AND 1900.

Kind.	1905.	1900.	Per cent. of increase.
Total tons	7,199,448	4,294,439	67.6
Total value	$22,450,503	$13,303,874	68.6
Can ice:			
Tons	6,695,789	4,139,764	61.7
Value	$21,020,547	$12,863,160	63.4
Plate ice:			
Tons	503,659	154,675	225.6
Value	$1,429,956	$440,714	224.5

The quantity of ice exported to foreign countries is decreasing. The author of this section of the Census Bulletin, Mr. Hugh B. Meloy, states that the quantity exported will probably decrease still further "as time advances, for artificial ice plants are being installed abroad, and steamships are being equipped with refrigerator sysems."

AN EXAMPLE OF THE PRESERVATION OF STEEL EMBEDDED IN CONCRETE.

In tearing down a one-story reinforced concrete building erected by the Turner Construction Co. in 1902 for J. B. King & Co. at New Brighton, Staten Island, Mr. H. C. Turner, the president of the erecting company, was able to discover much in regard to the stability of this kind of construction. The following account, which he has prepared, goes far toward proving that under ordinary conditions of loading and location and with proper precautions in building, reinforcing steel thoroughly embedded in concrete will remain free from rust.

This building had a pile foundation, the piles being cut off at mean tide level. The footings consisted of reinforced concrete placed around and over the heads of these piles. The walls had a thickness of 9 ins. up to the grade line and of 5 ins. from the grade line to the roof, a height of approximately 15 ft. The roof consisted of reinforced-concrete beams and girders, the roof slab having a thickness of 2½ ins., reinforced with ¼-in. twisted steel bars spaced 12 ins. on centers. The walls were strengthened by pilasters and both walls and pilasters were reinforced with twisted steel bars. The interior columns had a cross section of 11 ins. square and were reinforced with four ⅝-in. twisted steel bars held together by ¼-in. hoops of twisted steel spaced 2 ft. 6 ins. c. to c.

The portion of the building removed had an area of 30 × 60 ft. and was razed to make room for a five-story structure. No headway could be made in wrecking the roof by a hand hammer and point owing to the extreme hardness of the concrete. Sixteen-pound sledges were then used and were found very efficient in knocking holes through the roof slab, and when once a large hole was formed it was an easy matter to continue the wrecking.

The walls were pulled over by block and fall and showed very clearly the elasticity of the wall. These walls were anchored to the footings by bond bars which had been placed with the footing. Before falling the wall would lean at least 20° from the vertical and remain intact. The columns after being cut free at the top would bend back and forth like a sapling before the vertical bars would break. These bars finally broke at the junction between the footing and the column, permitting the entire column to fall over unbroken.

All steel reinforcement was found in perfect preservation, excepting in a few cases where the hoops were allowed to come closer than ¾-in. to the surface. Some evidence of corrosion was found in such cases, thus demonstrating the necessity of keeping the steel reinforcement at least ¾-in. from the surface. The footings were covered by the tide twice daily. The concrete was extremely hard and showed no weakness whatever from the action of the salt water. The steel bars in the footings were perfectly preserved, even in cases where the concrete protection was only ¾-in. thick.

A POWDER-MILL EXPLOSION in the Phoenix powder mills of the Du Pont Powder Co., at Edgemont, Pa., caused immense destruction in and about the plant, but did not result in any deaths.

TWO LOCOMOTIVES EXPLODED while in service during the past ten days. On Jan. 6, a switching engine of the "turtleback" type, blew up while in the Altamont, Md., yards of the Baltimore & Ohio R. R. The engineer was thrown a considerable distance, but was not killed. This is reported to be the third explosion in this type of locomotive on this road in the last few years. On Jan. 13, a locomotive on the Erie R. R. blew up just outside of Rutherford, N. J., killing the engineer and seriously injuring two others of the train crew.

THE WORST RAILWAY accident reported this week is from Ecuador where, on Jan. 10, at the town of Machachi, in the Province of Pichincha, 20 persons were killed and 40 injured in a wreck, the details of which are lacking in the dispatches. In the United States the most serious railway wreck occurred on Jan. 10, at Vinegar Bend, Ala., where a passenger train on the Alabama & Mississippi R. R. came into head-on collision with a logging train on a high-curved trestle. Both trains fell into the ravine and five persons were killed and two injured. On the Southern Pacific R. R., on Jan. 9, at Rucker, Cal., the Sunset Limited left the track, on account of spreading rails, and turned over. Three persons were killed and 18 injured. On Jan. 5, a freight and passenger came into collison just outside the Dubuque tunnel of the Great Western Ry. and three trainmen were killed.

THE NEW YORK SUBWAY was for a short time put out of operation over a portion of its length on account of the fire at the Parker Building at 19th St. and Fourth Ave., on Jan. 11. The building in which the fire occurred, as described in the article on p. 73 of this issue, was completely gutted and the walls seemed at first to be in imminent danger of falling. The line of the subway which here passes along Fourth Ave. immediately alongside of the building is built according to the standard I-beam and column construction with a reinforced-concrete slab about six or seven feet below the street surface. There was much apprehension among the authorities that the falling walls might crush in this roof and block the subway and perhaps cause a terrible accident to a passing train. Trains were therefore discontinued for this particular block until Monday morning after the fire (which occurred on Friday night). Finally, it was decided to lay upon the surface of the street a timber cribbing which could take up the impact of the falling mass in case the walls gave way. This crib consisted of 6 × 8-in. timbers laid about 8 ft. c. to c. along the line of the street and topped with the same size sticks spaced about 3 ft. c. to c. As soon as this cribbing was laid the subway trains again resumed schedules. Although later investigation seems to show that the walls are in no danger of falling, the timber cribbing will be allowed to remain to provide a possible safeguard in case of any collapse. Meanwhile the surface cars along Fourth Ave. are out of service for a considerable distance on either side of the building.

A THEATRE FIRE, ranking in disastrous consequences among the greatest holocausts on record, occurred at Boyertown, Pa., on the night of Jan. 13, and caused the death of about 200 persons. The fire occurred in the Rhoade's Opera House, a three-story brick building, in which an amateur performance, aided by a stereopticon show, was being given. During the display of the pictures, the hiss of some escaping gas from the tank supplying the machine caused a slight commotion among the audience and in an effort to discover the cause of the trouble, one of the performers back of the scenes lifted the flimsy curtain and knocked over an oil tank supplying a system of kerosene footlights. This escaping oil soon ignited and started a fire in the pit of the house. The theatre auditorium was a flat, rectangular one-floor room, with a center row of fixed seats and on each side, separated from the center by four-foot aisles, a row of loose chair seats. The main entrance was through a double-swinging door about 6 ft. wide from a steep four-foot wide staircase up one flight from the street. In addition there were two fire-escapes through windows, one on each side of the house, and a rear staircase leading from back of the stage. When the fire started there were about 425 people, mostly women and children, in the house. They were immediately thrown into panic by the burning curtain and stage and, forgetting for the most part the fire-escapes, all tried to rush down the narrow four-foot staircase, the entrance to which had been bolted by the doorkeeper to keep out non-paying spectators. It was at this doorway that most of the bodies were found, though many tried to reach the fire-escapes and the rear staircase. The narrowness of all exits soon blocked them and the fire, fed by the escaping oil and helped by the explosion of the calcium tank, rapidly destroyed the entire building, although local and neighboring fire departments were soon on the scene and did valiant work. Out of the 425 persons thought to have been present 167 bodies have been found as we go to press and about 40 more are in sight. This is a remarkably high percentage of deaths in proportion to those exposed to danger. Boyertown has a population of only 2,500, so that nearly 8% of the people lost their lives and nearly half of those in the room where the fire occurred.

THE CAISSON BLOW-OUT which occurred on Dec. 23, in the Seine River portion of the Metropolitan Railway tunnel in Paris and the first details of which we reported in a news note in our issue of Jan. 2, has been more completely described in later dispatches. As noted in Engineering News, April 11, 1907, p. 400, the station of the subway on the Ile de la Cite, between the two branches of the river, is being built with two vertical caissons, elliptical in plan and spaced about 216 ft. apart, connected by a horizontal caisson. There is left a space of about 5 ft. of earth between each vertical caisson and the end of the horizontal one, this space to be afterward covered by an enveloping caisson sunk from the surface. The two vertical shafts had already been sunk and the horizontal portion, which was being sunk from the surface and not bored as is common in most tunnels, was within 10 ft. of its final position, when the pressure of air blew out the connecting 5 ft. of earth and drove five of the workmen into the fissure, killing them instantly. Contrary to the first reports no permanent damage to the rest of the tunnel was caused.

A MISSOURI RIVER NAVIGATION CONGRESS is to be held at Sioux City, Ia., on Jan. 22 and 23. It is claimed that the Missouri can be made navigable for light draft steamboats from its mouth to Omaha or Sioux City at a cost of not more than $50,000 per mile and at the same time a great area of very valuable land in the river bottoms can be protected from erosion and destruction by floods.

THE SEPTIC TANK PROCESS PATENT held by the Cameron Septic Tank Co., of Chicago, Ill., has been upheld by the U. S. Circuit Court of Appeals, thus reversing the decision of the lower court in the suit brought by the company against the village of Saratoga Springs. (See Eng. News, March 28, 1897, for opinion of the lower court). The earlier decision held invalid both the claims for process and apparatus; the present decision, while declaring the process claims to be valid agrees with the lower court in holding that the claims for patentable apparatus are not well grounded. The patent in question was granted to Donald Cameron, Frederick J. Cammin and Arthur T. Martin, of Exeter, England, Oct. 3, 1899. Further information regarding the decision just rendered will be given in a later issue.

THE FLORIDA EAST COAST RY. extension to Key West was opened and has been completed from Miami to Knights Key, 109 miles, and was formally opened for traffic recently by the running of the first passenger train over the line, carrying the principal officers of the road including its President, Mr. Henry M. Flagler. At Knights Key connection is made with steamers for Havana, only six hours distant. Another year will be required to complete the remaining 47 miles to Key West. On the completed portion the total length of railway constructed in or over the water is 72,884 ft., or about 14 miles. The southern section to Key West will add 78,550 ft. to this, or there will be nearly 30 miles in all of over-water construction on the completed road.

SINGLE PHASE TRACTION EXTENSIONS on the New Caanan branch of the New York, New Haven & Hartford Railroad system, are currently reported. This line, of about 7.5 mi., extends from Stamford, which is the eastern end of the present electrically equipped terminal section of the main line. This branch has been operated by direct current for several years. It is proposed to run trains made up of one motor car and one trailing coach. The motor car will be a standard passenger coach (78,000 lbs.), properly equipped for the 11,000-volt system. The changes and additions will bring the weight up to about 120,000 lbs. The motor equipment will be four General Electric Company's 125-HP. motors of a new type.

THE ESTABLISHMENT OF A FEDERAL BUREAU of Mines is advocated by the Legislative Committee of the American Mining Congress, made up of Messrs. Jos. H. Richards, of Boise, Idaho; John Hays Hammond and Jos. Douglas, New York City; Dr. Chas. B. Dudley, Altoona, Pa., and others. Victor C. Alderson, of Golden, Colo., President of the Colorado School of Mines, is Secretary of the Committee.

THE GUNNISON TUNNEL, which is to form a part of the Uncompahgre Irrigation Project, in Colorado, had been holed to a total length of 20,488 ft. at the close of 1907, of which 689 ft. was done in December. The tunnel will have a total length of about six miles and will divert a considerable part of the flow of the Gunnison River into the Uncompahgre River.

PERSONALS.

Mr. James L. Tighe, M. Am. Soc. C. E., has been reappointed for a three-year term as City Engineer of Holyoke, Mass.

Mr. Robert P. Howell, Assoc. M. Am. Soc. C. E., has been re-elected for the fifth time Town Engineer of Phillipsburg, N. J.

Mr. Walter B. Snow, M. Am. Soc. M. E., has been elected President of the Alumni Association of the Massachusetts Institute of Technology.

Mr. Herman Nieter has opened an office at No. 2 Rector St. as Eastern Agent for the Canton Boiler & Engineering Co., of Canton, O., and the Braddock Machine & Mfg. Co., of Braddock, Pa.

Mr. George M. Cushing, Superintendent of Construction for the Ferrocarril de Moca a Santiago, in the republic of Santo Domingo, has resigned to take effect Jan. 11, 1908, and will return to the United States.

Mr. J. Walter Ackerman, M. Am. Soc. C. E., for the past six years City Engineer of Auburn, N. Y., has opened an office in that city for the purpose of conducting a general municipal consulting engineering practice.

Messrs. D. C. and Wm. B. Jackson, Consulting Engineers, have moved their western office from Madison, Wis., to the Commercial National Bank Building, Chicago, where Mr. William J. Crumpton will be in charge.

Mr. C. S. Weston has been appointed Superintendent of the Southwest Division of the Chicago Great Western Ry. and Mr. C. T. Blanks has been promoted to fill the position of Superintendent of the W. M. & P. Division, vacated by Mr. Weston.

Mr. W. T. Ingram, Engineer of Maintenance of Way on the Interoceanic Ry. of Mexico, has been appointed Superintendent of Permanent Maintenance of Way upon the Mexican Ry., to succeed Mr. T. A. Corry, who has resigned to enter railway work in Peru.

Mr. F. K. Rhines, formerly an engineer with the East Iron & Machine Co., Lima, O., and more recently Chief Engineer of the Dixon Engineering & Construction Co., Toledo, O., has become assistant to the Treasurer and General Manager of the General Fireproofing Co., at Youngstown, O.

Obituary.

Col. W. E. Cutshaw, M. Am. Soc. C. E., for 34 years the City Engineer of Richmond, Va., died on Dec. 19, 1907.

James B. Clow, President of J. B. Clow & Sons, manufacturers of plumbing and heating goods, died at his home in Chicago, Jan. 7, aged 76 years.

W. S. Jones, an engineer attached to the Topographical Bureau of the Borough of Queens, N. Y., died at his home in Glendale, L. I., on Jan. 14, aged 40 years.

Robert Reaves, at one time in the engineering department of the D., L. & W. R. R., but for the past 27 years Superintendent of the Scranton, Pa., Gas & Water Co., died at his home in Scranton, Jan. 9, at the age of 56 years.

Joseph M. Walker, Assoc. M. Am. Soc. C. E., Chief Engineer of the Lima & Toledo Ry. Co., died at Perrysburg, O., on Jan 7, aged 40 years. At the time of his death Mr. Walker was in charge of the large concrete bridge across the Maumee at Waterville.

George F. Evans, Vice-President and General Manager of the Maine Central R. R., died at Vanceboro, Me., on Jan. 10. Mr. Evans was born in Concord, N. H., in 1845 and since 1863, when he joined the U. S. Corps of Engineers at Portsmouth, N. H., he had been actively engaged in engineering work. The earlier part of his life was spent in river and harbor work in the middle west, but in 1881 he entered railroad work, in which he remained until his death. He had been connected with the Louisville, Evansville & St. Louis R. R., and the Boston & Maine R. R before becoming General Manager of the Maine Central.

ENGINEERING SOCIETIES.

COMING MEETINGS.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 15-17. Annual meeting at Champaign, Ill. (University of Illinois). Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago.

INDIANA ENGINEERING SOCIETY.
Jan. 16-18. Annual meeting at Indianapolis. Secy., Charles C. Brown, 408 Commercial Club Building, Indianapolis.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 20-25. Fourth annual convention at Buffalo. President, Richard L. Humphrey, 1001 Harrison Bldg., Philadelphia, Pa. Convention Manager, Dal H. Lewis, 760 Main St., Buffalo.

WOOD PRESERVERS' ASSOCIATION.
Jan. 21. Fourth annual meeting at Kansas City. Secy., C. W. Berry, Laramie, Wyo.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 21-23. Annual meeting at New York, Engineering Societies Building, 29 West 39th St. Secy., W. M. Mackay, 29 West 39th St., New York.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Jan. 23-25. Annual meeting at Chicago. Secy., C. R. Richards, Columbia University, N. Y.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 28-30. Annual meeting at Montreal. Secy., Prof. C. H. McLeod, 877 Dorchester St., Montreal.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 3-8. Annual meeting at Columbus, Ohio. Secy., Theo. A. Randall, Indianapolis, Ind.

AMERICAN CERAMIC SOCIETY.
Feb. 3-5. Annual meeting at Columbus, Ohio. Secy., Edw. Orton, Jr., Columbus, Ohio.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 11-12. Annual meeting at New Haven. Secy., T. F. Jackson, New Haven.

OHIO ENGINEERING SOCIETY.
Feb. 11-13. Annual meeting at Columbus. Secy., E. G. Bradbury, 85 North High St., Columbus.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 18. Annual meeting at New York. Secy., R. W. Raymond, 29 West 39th St., New York.

AMERICAN SOCIETY FOR TESTING MATERIALS.—The Secretary has announced that the following standard specifications and definitions have been adopted by letter ballot: Standard specifications for steel rails, standard tests for fireproof floor construction, definitions of standard defects in timber, standard names for structural timbers, and specifications for bridge and trestle timbers.

WESTERN SOCIETY OF ENGINEERS.—At the annual dinner, held at the Chicago Athletic Association Building on Jan. 7, the result of the election of officers was announced as follows: President, C. F. Loweth; Vice-Presidents, J. W. Alvord, P. Junkersfeld, and D. W. Mead; Treasurer, A. Reichmann. The Secretary, Mr. J. H. Warder, has been reappointed. During the present year the society's quarters in the Monadnock Block are to be extensively enlarged and improved.

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.—The fifth annual dinner of the Society was held in the Roman Court at Shanley's, New York City, on June 7. Addresses were made by Mr. George S. Rice, formerly Chief Engineer of the Rapid Transit Commission, and now Deputy Chief of the Public Service Commission; Comptroller Metz, of the City of New York; Messrs. Haffen and Cromwell, Borough Presidents of Bronx and Richmond Boroughs, respectively; Mr. Thompson, Commissioner of Public Works of Manhattan; Mr. Bumpers, Curator of the Museum of Natural History; Mr. Tompkins, formerly President of the Municipal Art Commission; Mr. R. W. Leslie, of Philadelphia, and Mr. Davies, Chief Engineer of the Hudson Companies.

IOWA ENGINEERING SOCIETY.—The twentieth annual meeting of the Iowa Engineering Society was held at Des Moines, Ia., on Jan. 8-9, 1908, with an attendance of about forty members. In the absence of President J. G. Ratcliffe, Vice-President Arthur J. Cox presided. The following papers were presented and discussed: The Development of Iron Mining in Iowa, J. G. Ratcliffe, Waukon; Chips from Along the Line of Experience, B. Schreiner, Des Moines; Street Grades, F. W. Dusey, Creston; Paving Adjacent to Street Railway Tracks, G. D. Dobson, Des Moines. In addition many committee reports were submitted and discussed. Among the pleasant features of the meeting were visits to the Locust St. concrete bridge, which is under construction and the factory of the Des Moines Bridge & Iron Works. The Society was tendered a banquet by the Des Moines Engineers' Club at which G. D. Dobson acted as toastmaster and toasts were responded to by C. R. Allen, B. Schreiner and L. H. Stone. The officers of the Society for the coming year are: President: Arthur J. Cox, Iowa City; Vice-President, C. T. Wilson, Waterloo; Secretary-Treasurer, A. H. Ford, Iowa City; Directors, C. R. Allen, Ottumwa, and W. H. Jackson, Des Moines.

CONCRETE ASSOCIATION OF AMERICA.—Arrangements are being made for the following societies and organizations to attend the permanent exhibition of the Concrete Association at the Brunswick Bldg., N. Y., on the dates mentioned, between the hours of 3 and 6 p. m.

Wednesday, Jan. 15, 1908—American Society of Civil Engineers.

Wednesday, Jan. 29, 1908—New York Chapter, American Institute of Architects.

Wednesday, Feb. 12, 1908—Building Trades Employers' Association.

Wednesday, Feb. 26, 1908—Brooklyn Chapter, American Institute of Architects.

Wednesday, March 11, 1908—The Mayor, the Board of Aldermen and officials of the City of New York.

Wednesday, March 25, 1908—Architectural League.

Wednesday, April 8, 1908—Real Estate Brokers.

Wednesday, April 22, 1908—Mechanical, Electrical, Mining and Refrigerating Engineers.

Wednesday, May 6, 1908—Board of Fire Underwriters and Insurance Brokers.

Wednesday, May 20, 1908—Students of Columbia University, New York University, Stevens Institute and Brooklyn Polytechnic Institute.

Wednesday, June 3, 1908—Engineers' Club, Brooklyn.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The regular meeting of the society on Jan. 8 was devoted to an informal discussion on "The Use of Reinforced Concrete in Engineering Structures." The discussion was opened by Mr. E. P. Goodrich with a resumé of what he considered some necessary improvements in the design and construction of reinforced-concrete work. In beams and girders the fatigue limit as determined by a large number of repetitive-load tests should be used as the basis of design and not a certain arbitrary proportion of the static breaking load as is most common at present. The present use of concrete columns would seem to be often uneconomical and sometimes unsafe, so so much so that it is extremely doubtful if the use is ever justified; it is certain that at present they should be prohibited in buildings over six stories high. The reinforcement in the longitudinally reinforced column is generally of such small area as to make it entirely useless in taking any of the load; in fact in such columns it would be much better to leave out all reinforcement and increase the cement in the mixture so as to make a stronger concrete. If cement manufacturers could turn out a cement of higher compressive strength than the present product it would be well worth while to use it in column work even at a much higher cost. In general design Mr. Goodrich advocated the use of the cantilever principle in beams and girders; that is, heavy reinforcement in the upper flange of the beams over the supports so that the greater part of the moment will be carried near the columns. As most concrete members are relieved of forms and take a large load in about two weeks after molding, he thought it advisable to use for unit stresses a safe proportion of fatigue stresses as determined on tests of two-week old pieces instead of the 30 to 90-day pieces now used as standards. Finally, the speaker advocated a 3-in. covering of fireproofing concrete on structural steel, the use of smooth rods instead of deformed, an investigation into the possibilities of making impermeable concrete and a waterproof cement, and an extended study of the effect of expansion and contraction in long walls.

The next speaker was Mr. Edwin Thacher, who devoted his entire time to the discussion of the action of concrete in sea-water. The attitude of European engineers and American seem to be very different on this question. The Europeans hold that there are certain constituents of sea-water which act upon the ingredients of cement to cause deterioration and that all concrete exposed to sea-water is in danger of disintegration. In America a number of experts have concluded from observation of existing work that there is no chemical action on concrete in sea-water, but that there is a decided physical action in the intertidal space due principally to mechanical erosion. In view of this the general opinion in this country would seem to be that concrete is a perfectly good material to use in sea work, provided that granite or other good masonry blocks be placed on the intertidal sea face to resist mechanical action. It is also recommended that heavy concrete blocks cast on shore and deposited be considered superior to mass concrete cast in place in the water.

Messrs. M. S. Falk and R. P. Miller showed on the screen several views of reinforced-concrete buildings in course of construction. The first speaker devoted all his time to illustrating buildings in which erroneous design and poor workmanship made erection both costly and slow and produced a structure which, to all surface appearances, was first class, but which in reality had a very small factor of safety. Mr. Miller showed principally views of unit systems of beam reinforcement, the use of which he advocated as the best method of avoiding misplaced steel, a common source of trouble in poorly inspected work. Mr. Sanford E. Thompson's portion of the discussion was entirely upon columns. He advocated the use of pure concrete columns well and richly mixed in preference to straight reinforcement. He explained the theory of the hooped columns and urged that its use be restricted, or at least the unit stresses on it be reduced, until more definite tests had been reported.

Mr. E. W. Stern recounted the Watertown arsenal tests on concrete blocks. These tests, made on a series of 1:2:4 12-in. concrete cubes out of the same materials and under the same conditions of workmanship, were tested in successive years for direct compression. The first year's tests were about 3,300 lbs. per sq. in., but each year thereafter showed a slight decrease until in about six years the compressive value was only 2,700 lbs. per sq. in. In view of the decrease in strength and the fact that these were laboratory tests made under optimum conditions, Mr. Stern recommended that a factor of safety of ten be applied in figuring a safe unit stress on concrete, thus giving a safe unit compressive value of 270 lbs. per sq. in. in a 1:2:4 mixture. Prof. W. H. Burr decidedly objected to Mr. Stern's suggestion as to factor of safety, and stated that, in his opinion, no concrete, made of uniform material under good conditions, ever deteriorated in compressive strength from age. From his knowledge of the action of concrete Prof. Burr would assume a factor of 5 or 6 in assigning a safe unit stress from an ultimate compression test. Furthermore, he thought that the present state of the art of reinforced-concrete construction is just as advanced as that of structural steel; in fact, in the knowledge of the behavior of the material gained from tests it was far in advance of any other material. Mr. H. C. Turner also defended concrete construction against some of the criticisms which had been made against it. Especially did he claim that safe construction in concrete, as in any other structural material, depended entirely upon an efficient and systematic organization. Such an organization had been developed by any number of the foremost reinforced-concrete construction companies.

It was announced that the next annual convention would be held in Denver, Colo., from June 23-26, instead of the following week, as at first reported.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. January 16, 1908.

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EDITORIAL.

An Official Statement on the Discontinuance of the "Technolexicon."

The discontinuance of the "Technolexicon" by the Verein Deutscher Ingenieure, noted in the last issue of this supplement, is explained in detail by a report made by the council of the society to the membership and printed in the Dec. 21 issue of the society's "Zeitschrift." The report makes clear the fact that the undertaking proved to be enormously costly; the society had already spent about $100,000 on the work when it was decided to discontinue it, and with the expenses of making a settlement with the contractual publisher, etc., the total outlay will approximate $120,000. There was every prospect that it would have required several times this sum, and a delay of seven or eight years to complete the work; in fact the report says explicitly that the work so far done, which has taken six years' labor and the expenditure of $100,000, "represents only a small part of the entire labor and cost" necessary to get out the projected dictionary.

Originally, that is after some two years' preliminary work, the council had reported to the society that the total cost of the work would be about $140,000, and that the principal part of the editorial work could be completed by 1907, while the publication would not be completed until the end of 1909. As a matter of fact, only the collecting of words and equivalents (in the three languages, German, French and English) had been completed by the end of 1906. This had been accomplished with the assistance of numerous voluntary contributors all over the world. The most redoubtable part of the whole work remained, namely the task of collating, completing and editing the mass of words and equivalents. This work, of course, had to be handled by the editorial office alone. It turned out that the progress of the editing was unexpectedly slow. For example, in four consecutive weeks in autumn, 1907, the regular editorial organization being at work, an average of 276 words per week was handled. Assuming therefore, an average weekly output of 300 words, a period of 40 years would be needed to complete the work, on the estimated basis of 600,000-700,000 words total. With all possible allowances, it seemed that the organization provided could not reduce this time to less than 10 or 12 years. The original estimate for the editorial handling was three years. To maintain a rate of working which would anywhere nearly correspond to this estimate, the cost of the undertaking would have been increased to a point far beyond the means of the society.

The discouraging result of this ambitious attempt will doubtless be an effectual bar against any further enterprise of the like kind in the immediate future. The Verein Deutscher Ingenieure retains possession of the material collected for the "Technolexicon," and thus will be in an excellent position to contribute toward, or cooperate in, any renewal of the undertaking. In the meantime the desirable thing will be the preparation of technical dictionaries in the individual languages, as we suggested in our last issue. A collection of such dictionaries will provide for a large part of the need which the multilingual dictionary was designed to meet.

CORRESPONDENCE.

Technical Books, Periodicals and Catalogs in Public Libraries.

Sir: My attention was called this morning to the editorial in your issue of Dec. 12 on technical works in public libraries, and it occurred to me that your readers might be interested in knowing that a special room was set aside in the main building of this library as a Useful Arts Room in March, 1902. In this room we have the recent books on applied science to the number of three or four thousand, and there are kept on file 260 periodicals, these mainly on applied science. Our Useful Arts Room is visited each day by 300 persons, most of them men; these are the manufacturers and experts, engineers, chemists, and electricians, and last but not least, the artisans. Cincinnati is a manufacturing city, and it has been our attempt for the pa t five years and more to make this department serviceable to such a city. As a bureau of information in applied science, with back of it a great storehouse of bound scientific periodicals and the older books containing such information, it seems probable that this department repays all that the Public Library costs.

N. D. C. Hodges, Librarian.

Public Library, Cincinnati, O., Dec. 16, 1907.

Sir: In your editorial headed "Technical Works in Public Libraries," appearing in your issue of Dec. 12, no mention is made of the very special effort which has been made for three years (now entering its fourth) by the Pratt Institute Free Library in this very direction. This library is the pioneer free circulating library in Greater New York, and is in every sense a "public library," except that it is not maintained under municipal control. The Applied Science Department was established in 1904, with a view to extend the library in the direction of technical literature, not only for distribution through our circulating system, but also for reference in the Applied Science Room. This room has grown to be an engineers' library and reading room of considerable proportions. The reserve collection of books aims to be wholly up-to-date and authoritative, covering almost every field of engineering. Over 130 current trade and technical papers are regularly received here, to the exclusion of all popular literature. We have from the beginning pointed with pride at our collection of *trade catalogs*, which has been a very useful adjunct to our work. I am enclosing a little notice of this room, issued a year ago. The notice explains the purpose of the Applied Science Room and invites "workingmen, mechanics, students, chemists and engineers" to visit it.

I have taken this opportunity to introduce the Applied Science Department of this library to the Engineering News, with which journal the department has so long been acquainted as a most indispensable weekly acquisition.

Very truly yours,

Edward F. Stevens,

Head Applied Science Department.

Pratt Institute, Brooklyn, N. Y., Dec. 12, 1907.

Sir: I notice in your number for Dec. 12 a short editorial in regard to trade catalogs in public libraries. The Goodwyn Institute Library is a reference library to be developed along technical lines. We have just opened, and as Memphis is becoming more and more a manufacturing and industrial center, I am very anxious to get all the trade catalogs possoble.

Very truly yours, E. B. Wilkerson,

Memphis, Tenn., Jan. 10, 1908. Librarian.

REVIEWS.

Unwin's Hydraulics Revised.

Reviewed by GARDNER S. WILLIAMS,*, M. Am. Soc. C. E.

A TREATISE ON HYDRAULICS.—By William Cawthorne Unwin, LL. D., F. R. S., M. Inst. C. E., Hon. M. Inst. M. E., Hon. M. Am. Soc. M. E., M. Inst. E. E., Emeritus Professor of the Central Technical College, London, England: Adam and Charles Black. Cloth; 5¼ × 8¾ ins.; pp. 327; 149 illustrations in the text. 12s. 6d., net; American price, $5.

Among the many masterly monographs in that greatest of English Collections, the Encyclopedia Britannica, probably none has been of more service to the engineering profession than that entitled "Hydro-mechanics," prepared by Professor Unwin in 1876. By those familiar with that excellent contribution the announcement of a "Treatise on Hydraulics" from the pen of the same distinguished author will be hailed with a satisfaction not untinged with enthusiasm, but by such it must be remembered that what was an excellent treatise in 1876 is not now necessarily entitled to similar commendation.

In his preface Professor Unwin expresses the relation between the purely mathematical science and that which the practicing engineer acquires as follows:

> Strictly rational hydrodynamics, so far as it has been developed, is concerned mainly with fluids deprived of viscosity, and leads to results flagrantly at variance with the action of actual fluids. Hence in dealing with the practical problems of hydraulics the engineer has recourse to comparatively simple mechanical principles and simplified assumptions, which furnish rough formulae, which can be modified by empirical constants so as to be true to the necessary approximation over any required range of conditions.

An eight-page "Introduction" is devoted to a concise presentation of the units of measurement —English, French and American—and conversion tables, therefor, together with values of physical constants. In the first chapter the "Properties of Fluids" are discussed with a directness and absence of detail worthy of the student of that great founder of modern engineering —Professor Rankine. The student of this chapter, as indeed of the whole work, should, however, be well grounded in mechanics. Chapter II. is devoted to the "Distribution of Pressure." Here, in the treatment of the stability of a wall, one is somewhat surprised to find that the methods of that eminent preceptor have been departed from, and the sanction of the distinguished author given to the pernicious practice of computing moments of stability about the toe of a dam; and considering the frequency with which practical details are introduced in the text, the omission of a discussion of the effect of percolation underneath the structure is at least noticeable.

Chapter III., "Principles of Hydraulics," opens with a review of the work of Osborne Reynolds and the limitations of hydraulic formulae, takes up Bernouilli's theorem and its applications to contractions and expansions, and presents an analysis of the variation of pressure across the stream lines in curved motion, and the equations of vortices. Chapter IV. is devoted to the "Discharge from Orifices" and is virtually a condensation of a portion of the Encyclopedia Britannica article, with some additional experimental data from the work of Ellis and of Mair, and a reference to the nozzle experiments of Freeman.

Chapter V., on "Notches and Weirs," is again an abridgement of the previous treatise, with tabular data from the Cornell experiments and a very brief resumé of Bazin's work.

The book has everywhere the distinctive earmarks of an English publication in the crudity of the illustrations, most strikingly exhibited in this chapter by the inversion of the figure relating to Bazin's experiments, and on page 70 with characteristic English inaccuracy Uriah Boyden is referred to as Mr. V. Boyden.

In Chapter VI., the author, with an arrangement similar to Church's Hydraulics, introduces the subject of "Compressible Fluids," and the application of Bernoulli's theorem thereto.

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Chapter VII. deals with Fluid Friction. Here Froude's classic experiments on surfaces dragged through still water, and those of the author on rotating disks, are discussed at considerable length, but the friction of moving water against stationary solids is not included.

Chapter VIII., "Flow in Pipes," begins with a brief discussion of the work of Reynolds and the later experiments of Coker, Clement, and Barnes on stream-line flow, and passes to the subject of ordinary flow and the Chezy formula, Darcy's experiments and the formulae proposed by Maurice Levy. The work of Hamilton Smith, Jr., is utilized, as is that of Herschel, the Ogden experiments, and the hose investigations of Freeman. Weisbach's equations for enlargements, contractions, bends and curves are presented, and with the last are some deductions from the experiments of C. W. L. Alexander on 1¼-in. diameter curved pipes and a reference to the Detroit experiments on 30, 16, and 12-in. pipes. This last reference has evidently been taken second-hand from Mr. Alexander, for the author's conclusions therefrom are flatly contradicted by the actual experiments, and a theory of curve resistance in harmony with the latter, is presented in the discussion of the paper to which reference is made. In view of the care with which these experiments were made and the extent of ground covered, and the published work in connection therewith of Saph and Schoder and of Adams and Wilson, such statements as that on p. 171

> the total resistance of a bend is made up of the skin resistance of a straight length of pipe of the same length as the bend, and an additional resistance due to the curvature which is not shock resistance, but merely an augmentation of the *skin friction* [and later (p. 172)] for any other bends the resistance will be proportional to the angle subtended at the center of curvature,

could not possibly have been made by one who had even casually read the discussion of this subject in Vol. XLVII. of the Transactions of the American Society of Civil Engineers.

The data on resistance of gates and branches presented in the Detroit experiments are overlooked, but Weisbach's coefficients are given, as are those derived by Kuichling on a 24-in. sluice gate.

Chapter IX., on the "Distribution of Water," follows generally the earlier monograph and is an excellent presentation of the subject from both the practical and the theoretical standpoint, and is brought well up to date. It includes an analysis of the problem of the proper diameter for a suction pipe, and a short presentation of the subject of water hammer, and also of corrosion and incrustation of water mains.

Chapter X., the author entitles "Later Investigations of Flow in Pipes." The reader is led to hope that here he will find the judgment of a master passed on the recent accurate investigations of this subject, and the hope is encouraged by the prompt dismissal of the Kutter formula with the terse statement: "There is no good reason for thinking that this formula is specially accurate for flow in pipes." The defects of the Chezy formula in its variable coefficient are then considered in the light of Darcy's experiments. The influence of temperature is shown by Hagen's investigations, and Mair's experiments on a 1½-in. pipe are commented upon, but the most carefully conducted series of hydraulic observations on record, of over 700 experiments upon diameters ranging from 0.1-in. to 2 ins., made by Saph and Schoder at the Cornell Hydraulic Laboratory, and published nearly four years ago in the Transactions of the American Society of Civil Engineers, has, apparently, not yet been seen by Prof. Unwin.

Considering the experimental data available, the author properly gives to the work of Darcy first place, but he is disturbed by the fact that the losses in Darcy's two pipe sections of equal length do not agree, that in the down-stream section being always the greater. Had he taken sufficient interest in the matter to familiarize himself with the influence of contractions on the distribution of velocity in the stream, as set forth in the discussion of the Detroit experiments, and, with especial reference to this particular case, in the Journal of the Association of Engineering Societies for March, 1901, he would have found that this fact, instead of being an indication of slovenliness, as the reader is left to conclude, is actually an evidence of the accuracy of the work, and, instead of taking for his computations the defective value for the up-stream length, he would have used the more correct results from the down-stream section. Hamilton Smith, Jr., the Bonn Water-Works, Lampe, Stearns, Gale, and Bossut comprise the remaining authorities tabulated on loss of head; all were treated in Hamilton Smith's work, published 21 years ago. From these experiments an exponential expression is derived of the form

$$\frac{h}{l} = \frac{m}{d^x} \cdot \frac{v^n}{2g},$$

in which h, l, d, v, and g have the usual significance, and m, x, and n are experimental constants, a table of values for which is presented both for French and English units. Omitting the case of tuberculated pipe the mean values are $m = 0.0244$, $x = 1.194$, $n = 1.857$. The formula then reduces to $S = \frac{0.00038\ V^{1.86}}{d^{1.20}}$ which coincides closely with the formula $S = \frac{0.00038\ V^{1.86}}{d^{1.25}}$, derived in 1903 by Saph and Schoder at Cornell University by considering, in connection with the foregoing investigations, their own, Fitzgerald's, Herschel's, Bazin's, Kuichling's, Benzenberg's, the Detroit and the Ogden experiments, as well as some others; and also with the Hazen and Williams formula, $S = \frac{0.00037\ V^{1.85}}{d^{1.16}}$, which was derived for cast iron pipe especially. For new cast iron the author recommends $S = \frac{0.000336\ V^{1.85}}{d^{1.166}}$, and for tuberculated pipe, $S = \frac{0.0007\ V^{2}}{d^{1.16}}$.

The author then takes up the "distribution of velocity in the cross section of a pipe" and awards to Bazin the palm for the most exact research in this subject. As he exhibits no familiarity with the work in this line, either at Detroit or Cornell University, his authority in this matter may be questioned. The statement of the ratios of maximum to mean velocity for Bazin's experiments is incorrectly given as 1.24 instead of 1.168 for normal conditions, and the inverse ratio given as 0.8 should be 0.85. The chapter closes with another reference to the work of Mr. J. G. Mair, on the 1½-in. pipe, regarding temperature effects, but presents none to the American experiments at Cornell or at the Experiment Station of the Massachusetts State Board of Health.

Chapter XI. is devoted to the "Flow of Compressible Fluids in Pipes," and in this the treatment departs considerably from that in the Britannica article of the monograph, the conclusions being modified in the light of recent investigations. This chapter presents in condensed form the material available up to about 1904.

Chapter XII., "Uniform Flow of Water in Canals and Conduits," begins with a derivation of the Chezy formula, and after briefly presenting the results of the Darcy and Bazin researches, takes up the Kutter formula and points out that "a formula with so many arbitrary constants can, of course, be made to agree with any selected set of results of gaging more closely than a simpler formula." "But," the author continues, "the formula has only the authority of the results used in obtaining it. If some of these are untrustworthy, the formula must be untrustworthy also." He then states that the term $\frac{0.00281}{s}$ was introduced on the authority of the Humphreys and Abbott gagings, which being made with double floats are now known to be unreliable. And, finally, following Bazin's analysis, he shows the irrationality of the formula and calls attention to its wide deviation from experimental results. Bazin's formula, which is presented in the equation, $v = \frac{157.6\sqrt{RS}}{1 + \frac{n}{\sqrt{R}}}$, with values of n ranging from 0.109 for smooth channels to 3.17 for excessively rough canals, is then considered with approval ,and the experiments of FitzGerald on the Sudbury Conduit are referred to (Trans. Am. Soc. C. E., 1900). Tables of the constants for the above formula are given and data from the Loch Katrine Aqueduct, published some ten years ago, are presented. The usual discussions of egg-shaped and trapezoidal channels follow, with a solution of the problem of discharge for different depths of flow. Some data on rainfall and run-off, presumably from English sources, are given, and the distribution of velocity in an open channel is considered, the work of Darcy and Bazin, Fteley and Stearns, Humphreys and Abbott, Cunningham, Eger, Plenkner and Harlacher being utilized. Bazin's later conclusion, that at the lower depths the velocity curve is like that in a pipe, very nearly an ellipse tangent to the bottom, has been overlooked. Various forms of aqueducts are presented, and the mechanics of river bends is dealt with according to the theory of Professor Thomson.

Chapter XIII. deals with "Gaging of Streams." Gaging by slope, by surface, subsurface, double, and rod floats are first treated. Under the head of rod floats the investigations of Francis and all reference to his very accurate formula for the reduction of such observations are conspicuously absent. The current meter is then taken up, but the utilization of the Francis equation for observations with this instrument is, of course, omitted. The rating of meters in still water is discussed.

The Pitot tube is then considered and a serious misstatement is made with reference to the Detroit experiments, where the experimenters are quoted to the effect that the coefficient of the instrument is unity. No such statement as to the complete instrument appears in the article quoted, and, furthermore, it is incorrect, unless the pressure orifice is located in a surface of sufficient extent to reduce the adjacent velocity to equality with that at the wall of the channel, a point which is seldom appreciated. The discussion of river gaging, which follows closely the Britannica article, is relatively quite comprehensive, but, unfortunately, undue prominence is given to misleading investigations. Gaging by means of chemicals is described in a short paragraph, without discussion of its limitations.

Chapter XIV. considers the "Impact and Reaction of Fluids," the treatment being by means of the ordinary momentum equations. The problems dealt with in the Encyclopedia are repeated and extended by Stanton's experiments

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No course in civil engineering is complete without a thorough course in railroad location, for the methods used on railroad surveys are applicable to highway surveys, canal surveys, etc. A book that is admirably adapted for use as a text-book, or as a supplement to lectures, is Railroad Location Surveys and Estimates, by F. Lavis, M. Am. Soc. C. E. It has been adopted by several engineering colleges, and is generally conceded to be the clearest exposition of modern field methods yet published. It is written by an engineer of wide experience in railway work. The book contains 270 pages, and its price is $3, net, postpaid.

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(Proc. Inst. C. E., 1903) on the resistance of planes to currents of air. Wind pressure is treated in this chapter with considerable detail, and Baker's work on the St. Louis tornado is quoted.

The chapter is followed by a few problems bearing on the preceding text. The book closes with an appendix of tables including computations of flow in pipes by the author's exponential formulae.

Considered as a whole, the treatment, from the scientific point of view, is terse, accurate and concise but the many admirers of Professor Unwin will close the book with a feeling of disappointment that the writing of it has been permitted to partake of the nature of pastime rather than of strenuous work.

When an obscure instructor, to eke out an insufficient and precarious income, writes an essay to be used as a text-book in his classes, only the limited number who are his students have a right to complain of the shortcomings of his book, and for them the book will probably be as safe as the instructor; but when one of the reputation and ability of this author produces a treatise on any subject, and gives to its statements the weight of authority of a great name, not only his students, but also the scientific world, and even the general public, have a right to demand that he take sufficient care in its preparation to insure the utmost of attainable accuracy in every particular, and that a work with the date of July, 1907, shall present the achievements of science in the branches treated to later times than 1886 or even 1900. Comparing this work with that of Edward S. Bellasis (Rivingtons, London, 1903), unfortunately likely to become far less known, one finds in it much less of value, and in fact, omitting the two and one-half chapters on pneumatics, and the exponential formula, almost nothing not as well or better treated in the other work. Historically, as quite possibly a last production of any who sat under the teachings of the great Rankine, the book is entitled to a place on the engineer's book shelves, but for practical value and up-to-date appreciation of the subject, the work of Bellasis is to be chosen many times over.

STATISCHE UNTERSUCHUNG VON BOGENUND WOELBTRAGWERKEN.—In Stein, Eisen, Beton oder Eisenbeton nach den Grundsätzen der Elastizitätstheorie, unter Anwendung des Verfahrens mit Konstanten Bogengrössen. By Dr. Robert Schönhöfer. Berlin, Germany: Wilhelm Ernst & Sohn. Paper; 6½ x 9¾ ins.; pp. 36; eight illustrations in the text. 1.80 marks; American price, 72 cts.

A method of arch analysis is here demonstrated which depends on the division of the arch axis into sections whose lengths are proportional to their mean moments of inertia, in order to simplify the application of the formulas, as is done in Cain's method. The author devised a simple graphical operation for dividing the arch in this proportion.

PERU IN 1906.—With a Brief Historical and Geographical Sketch. By Alexander Garland, Member of the Lima Geographical Society. Originally Written in Spanish, and Translated into English by George R. Gepp. Lima, Peru: "La Industria" Printing Office. [From Eduardo Higginson, Consul General del Peru, 25 Broad St., New York.] Stiff paper; 9¾ x 14½ ins.; pp. 303; folding and other plates.

We have here a very interesting account of Peru—historical, geographical, climatological, industrial, political, commercial, financial, etc. Quite a bit of interesting information is given regarding the city of Lima and some of the other minor civil divisions of Peru. Numerous handsomely-engraved illustrations are included. It is interesting to note that "The Technical Board of Valuations of Lima [is] composed of engineers, architects and land surveyors." Besides making assessments for taxation purposes, this Board has established the rules to be followed in judicial valuations and in their formation, in the estimates for public works, fixing the value of the unity of the constructions. It also affords information as to what is customary in those valuations and about the prices of materials.

We may also note that "The Technical and Industrial Institute of Peru," created by the Government in May, 1906, is a union of various technical and industrial societies. The Institute serves "the Government as a consultative board and the public as a center of information and explanation in technical and industrial matters." The Institute and its component societies are subsidized by the Government. The volume contains interesting information regarding the School of Engineers of Lima, and also regarding other educational institutions.

A German Symposium on Railway Track and Accessories.

Reviewed by JOHN G. BAUKAT.*

OBERBAU UND GLEISVERBINDUNGEN.—Section 2, Part II. (Der Eisenbahn-Bau der Gegenwart). Die Eisenbahn-Technik der Gegenwart. Prepared by A. Blum, Berlin; Schubert, Berlin; Himbeck, Berlin; Fraenkel, Tempelhof. Second edition, enlarged. Wiesbaden, Germany: C. W. Kreidel. Paper; 7¼ x 11 ins.; pp. 145 to 459; 2 plates and 440 text illustrations. 12 marks; American price, $4.80.

Even before opening this book the reader is impressed with its importance, for the top line of the cover bears the proud announcement that it has been found worthy of a prize by the Verein Deutscher Eisenbahn Verwaltungen (Association of German Railway Managements). On further examining the cover one finds that the book is a composite work, for every department of the subject is handled by a recognized specialist in that particular field. Besides, the publication was under the jurisdiction of five government railway officials so that it almost possesses the dignity, though not the dryness, of a government blue book.

A work prepared under such elaborate auspices leads the reader to form great expectations of the value of its contents. In this, fortunately, he is not disappointed. Instead of finding merely a compilation of notes on current track-construction practice, with little or no illuminating comment to explain why this is bad or that good for certain conditions, the reader will find a series of splendid educational articles, logically arranged and bristling with the details so beloved by the German engineer.

The book opens with an article defining in very simple terms the meaning of track ballast, ties and their functions on different classes of railroads. From this the writer passes to the reasons for adopting certain standard wheel pressures and gages, presents calculations relative to widening the track gage and raising the height of the outer rail at curves; and following this by a second article discussing the comparative values of longitudinal sleepers and cross-ties. In taking up the latter feature the writer does not shirk a thorough mathematical treatment, but the reader who does will still find in the resultant curves and other diagrams many valuable data, sufficient for most practical purposes. A discussion, with calculations, on rail joints completes this section.

The third article relates to the drainage and ballasting of track on the right-of-way, at station terminals. Numerous cross-sections are presented, including examples of American steam railroad practice, with comments regarding their applicability to European conditions. This article is accompanied also by some interesting drawings and half-tones showing some of the bad effects of insufficient height of ballast.

The fourth article, covering rails and their installation, is comprehensive enough to be a book by itself, and a valuable one too. Herein the writer first discusses the evolution, manufacture and qualities of the principal rail sections and fixtures used in Europe and America. He then considers the question of wooden ties, their cost, the comparative maintenance of different woods, methods of installation and processes for preserving them. Concrete ties are illustrated and treated somewhat briefly, but detailed consideration is given to metal ties. Next the author mentions several methods for preventing rail creeping, discusses the spacing of ties and rail joints and refers to different styles of rail joints and guard rails. The concluding paragraphs are devoted to tieless railway construction and a few types of street railway track work.

What might be termed the second part of this volume is entitled "Gleisverbindungen" (Track Connections). It begins with elementary definitions of the various kinds of switches and crossings, but in short order is followed by an ex-

*Assistant Superintendent of Electrical Equipment, N. Y. C. & H. R. R. R. Co., 335 Madison Ave., New York.

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tended description of the functions of each piece of apparatus. From this the writer passes to details of construction, including parts used in connection with semaphore levers, etc. Much attention is given, also, to many kinds of crossings, after which the writer gives a series of calculations for laying out switches.

The final chapters relate to numerous classes of turntables, transfer tables and other means for shifting cars and locomotives in terminals and shops.

Considering the volume as a whole, one may say that while mainly illustrative of European steam railroad practice, in which our high-speed heavy trains are almost unknown, the American track engineer conversant with German surely will find this book worth his careful attention. It is not advisable, however, for anybody to buy the paper-bound edition, for it certainly does not stand much handling, as the reviewer regretfully discovered.

Engine Balancing.

Reviewed by LIONEL S. MARKS.*

BALANCING OF ENGINES.—Steam, Gas and Petrol. An Elementary Text-Book, Using Principally Graphical Methods. For the Use of Students, Draftsmen, Designers, and Buyers of Engines. By Archibald Sharp, Assoc. M. Inst. C. E. London, New York and Bombay: Longmans, Green & Co. Cloth; 5½ × 8¾ ins.; pp. 212; illustrated. $1.75, net.

The Balancing of Engines was, until a few years ago, very inadequately treated in the existing books on that subject, although much valuable matter had been communicated to the engineering societies. In 1902 there appeared Professor Dalby's book, a work whose lucidity, thoroughness and adaptation to the use of the student and designer were such that it became at once the standard work and still retains that position. Any new book must, unless it departs entirely from the accepted methods of treatment, owe a large debt to Professor Dalby's book. That indebtedness is plainly to be seen and is readily acknowledged by Mr. Sharp. A criticism of his book must be primarily a criticism of those parts which either are not treated or which are handled in a different manner in the earlier work.

As a whole, the book before us is admirably clear and well written. The first two chapters, which deal with the preliminary conceptions and theorems in mechanics, contain some very helpful sections for the student with slight knowledge of the subject, notably in the tabular comparisons of linear and rotary motion, in which it is made very clear that each formula in linear motion has its analogue in rotary motion, when angle and moment of inertia are substituted for length and mass. In the treatment of the inertia forces of revolving masses a purely graphical method is used for dealing with the longitudinal couples when the masses are not revolving in the same plane; a method which seems to offer some advantages over the usual semi-graphical, semi-arithmetical method.

For the determination of the forces necessary to accelerate the piston and cross-head, a mixture of analytical and graphical methods is used. The analytical investigation is carried out more completely than is usual. In the expression for the acceleration of the reciprocating parts in terms of functions of the crank angle and its multiples, the exact values of the coefficients of these functions for different ratios of length of connecting rod to crank are determined and tabulated. The inertia forces of the second and higher orders are then calculable, and for purposes of graphical treatment, they are considered as due to masses driven with simple harmonic motion from imaginary cranks revolving at speeds which are simple multiples of the speed of the engine shaft. Particular applications of this method are made to four, five and six-cylinder engines with cylinders in the same axial plane, and the conditions for perfect balance of the primary and secondary forces and couples are found. The transverse couples of primary and higher orders due to the connecting rod are similarly treated. An interesting feature is the determination of the unbalanced forces in multi-cylinder one-crank engines, including the two-cylinder V-type, which has been used for motor-bicycles, motor-cars and launches; the three-cylinder "Brotherhood's" type; the four-cylinder type, which has been used for hydraulic engines; and a five-cylinder engine, which so far has not been practically realized.

The most important contribution which Mr. Sharp makes, however, is in his discussion of the kinetic energy of pistons and connecting rods. The energy of the piston, the linear energy of the connecting rod, and the angular energy of the connecting rod are all determined analytically in terms of the crank-angle and its multiples, and the coefficients of the functions of the crank-angle are tabulated (for various ratios of connecting rod to crank) as far as the sixth order. The sum of the three quantities is the total kinetic energy of the reciprocating parts; the terms involving the crank-angle show the fluctuation of energy of the mechanism as the crank-shaft revolves, while the sum of the terms which are independent of the crank-angle gives the average kinetic energy of the reciprocating masses. A graphical method is used to determine the average kinetic energy and the fluctuation of kinetic energy, when several engines are on the same shaft. An interesting study is then made of the "fly-wheel effects" of the reciprocating parts with various combinations of engines on the same shaft. This problem is particularly interesting from the point of view of the probable application for internal-combustion motors to marine use in the near future. Since the use of fly-wheels is not practicable in this case, it is most desirable that the kinetic energy of the reciprocating masses should be both considerable and constant in amount. The problem is worked out for many combinations of engines, some of which are new. The generation of great power in a small number of cylinders is inadmissable on account of the unbalanced forces. Consequently, eight, ten, twelve, or possibly even twenty-four-cylinder engines may have to be used. The dynamical properties of such engines are worked out. An eight-cylinder four-crank V-type engine with cylinders at 90° has very slight variation in kinetic energy, but will have some appreciable variation of torque if the engines are of the four-cycle type. Combinations of either two or three sets of the eight-cylinder, making sixteen or twenty-four-cylinder engines, are perfectly balanced, have practically constant torque, and constant kinetic energy of the moving parts, so that they should compare with the steam turbine in smoothness of running and absence of vibration.

Another interesting feature is a new method of determining the cyclic variation of speed of an engine which has to run at different average speeds—as for marine, locomotive and automobile practice.

Throughout the book the author has obviously kept in mind multi-cylinder gas and oil engines rather than steam engines, though the methods are naturally applicable to all engines. The numerous illustrative examples which are worked out are practically all on gas engines. Moreover certain special problems in automobile practice are considered, as, for example, the fly-wheel effect of the linear energy of the whole car, and the function of fly-wheels in automobile practice. The book is consequently of special value to automobile engineers.

*Assistant Professor of Mechanical Engineering, Harvard University, Cambridge, Mass.

THE HUDSON BAY ROUTE.—A Compilation of Facts with Conclusions. By J. A. J. McKenna. Published by Direction of The Hon. Frank Oliver, Minister of the Interior, Canada. Paper; 6½ × 10 ins.; pp. 55; folding and other plates.

This is a most interesting study of a tide-water freight outlet for Central Canada by means of some 500 miles of railway running a little east of north from Le Pas to Churchill. Le Pas is or soon will be the terminus of a line of railway extending to the northward from Winnipeg. The conclusions of the report are that, by building less than 500 miles of railway, a very important and useful outlet for grain and cattle could be had to Europe, by means of Hudson Bay and Hudson Straits. Large savings in rail transportation would be effected for the great wheat-producing areas in Western Canada, and the water route to Liverpool would be about the same as that from Quebec. The average saving in rail-transportation distance for Manitoba, Saskatchewan and Alberta is figured at 967 miles. The report contains an interesting historical summary of matter relating to Hudson Bay and the period of the year during which it is open to navigation, a like summary regarding the territory south of Hudson Bay along the route of the proposed railway, and a brief summary report by Mr. W. Thibaudeau on an exploratory survey of the proposed railway line made between Sept. 2, 1906, and Feb. 16, 1907.

AMERICAN WATER-WORKS ASSOCIATION.—Proceedings of the Twenty-seventh Annual Convention, Toronto, Ont., June 17 to 21, 1907. Charleston, S. C.: J. M. Diven, Secretary-Treasurer. Cloth; 6 × 9 ins.; pp. 527; 65 illustrations.

Papers and discussions on many phases of water-works construction and operation, by engineers and by water-works officials, are here presented. Considerable good money has been wasted and the possible convenience of the volume decreased by inserting some enormous folding plates. Proper editing, drafting and engraving would have eliminated nearly all if not all the folding plates. One of these plates is nearly 25 × 30 ins. in size. A few hours time on the part of a competent draftsman would have made it possible to reduce this illustration to such a size that it would have gone readily in the text. Most of the other plates might well have taken the same course and some might have been omitted without loss to anyone. The net result would have been (1) a considerable saving of bills paid for engravings and for special paper for folding plates and (2) a far handier volume than is now before us. A further saving in the cost of the Proceedings could have been effected, with accompanying gain in convenience, by using smaller type for tabular matter placed in the text. Tables are for reference, and, frequently, for the ready comparison of figures. They should therefore be as compact as is consistent with usability. Another and less important though inexcusable fault is the failure to place titles below the half-tone engravings of some of the interesting views of foreign water-

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work's plants. Our criticisms regarding line drawings are equally applicable to the proceedings of some of the other technical societies, but we make them here because experience has shown that this association, under Mr. Diven's Secretaryship welcomes and acts upon suggestions designed to be useful.

A Classic Book on Landscape Architecture.

THE ART OF LANDSCAPE GARDENING.—By Humphry Repton, Esq. Including His Sketches and Hints on Landscape Gardening and Theory and Practice of Landscape Gardening. Edited by John Nolen, A. M. Boston and New York: Houghton, Mifflin & Co. Boards; 6 × 9¼ ins.; pp. xxiii. + 252; 23 plates and 28 text illustrations. $3, net; postage, 22 cts.

Humphry Repton was one of the earliest, most talented, sane, capable and experienced of the English landscape gardeners who followed Launcelot Brown in breaking away from the formal school of landscape art and striving to adapt the beauties of nature to the conveniences of man. Repton lived from 1752 to 1818. He had a hand in laying out or improving more than two hundred more or less extensive grounds, often including the design or alteration of buildings. His practice was to submit to each client a Red Book, or report consisting of text and numerous sketches, neatly bound in red. These reports, which were written in clear, forceful language, without technicalities, often discussed the principles of landscape gardening, as suggested by the work in hand.

As a natural outgrowth of the habit just named, the large amount and variety of work accomplished, and the criticisms elicited by his work and conversations, Repton published "Sketches and Hints on Landscape Gardening," in 1795, followed in 1803 by a more ambitious work, entitled "The Theory and Practice of Landscape Gardening."

In each work the author drew largely upon his Red Books, for both text and illustrations, referring to about sixty of these reports in his earlier and a hundred in his later book.

These two books by Repton, edited to meet present-day needs, have been combined in one handsomely made volume and form the first of a series of classics in landscape architecture, the publication of which has been suggested by the American Society of Landscape Architects. These re-editions will be welcomed by many who would otherwise be unable to own notable books, now unpurchasable or to be had only at high prices.

Of the initial volume of the series little more need be said, except that it deals in an interesting, readily understood, but dignified manner with the principles of landscape gardening, or, as many now prefer, landscape architecture. The grounds laid out or improved by Repton, perhaps it should be said, were gentlemen's estates, large and small, and though these, or portions of them, were called parks, they were private rather than public parks, and each was associated with a residence, permanent or temporary. Many of the principles so clearly set forth, however, apply equally to either public or private work.

As a piece of bookmaking the volume before us is all that could be desired, or at least all that could be reasonably expected for such a book and price.

A POCKET-BOOK OF MECHANICAL ENGINEERING.—Tables, Data, Formulas, Theory and Examples, for Engineers and Students. By Charles M. Sames, B.Sc., Mechanical Engineer. Third Edition, revised and enlarged. Jersey City, N. J.: The Author. Leather; 4 × 6½ ins.; pp. 195; 39 illustrations in the text. $2.

The usefulness of any reliable handbook is largely a matter of personal opinion which in turn depends on each user's particular field of activity. No pocket manual of any branch of engineering can entirely satisfy all the workers in that field and the more compressed the data and information become the more difficult becomes the task of arranging the handbook so as to meet the needs of the greatest number. Mr. Sames' pocket-book was first compiled in 1905, to meet what was felt to be the definite need of a small volume easily carried in the pocket, but one which would contain most of the reference needed by a mechanical engineer when away from his desk. The usefulness of the book which resulted is evidenced by the appearance of the third edition.

New matter appears in this edition on reinforced concrete, high-speed tool steel, superheated steam and journal friction. The book now contains sections on mathematics, chemistry, properties of materials, energy and power transmission, heat and the steam engine, hydraulics, shop practice and electricity.

ENGINE-ROOM CHEMISTRY.—A Compend for the Engineer and Engineman. By Augustus H. Gill, Ph. D., Associate Professor of Technical Analysis of the Massachusetts Institute of Technology, Boston, Mass.; Author of "Gas and Fuel Analysis for Engineers," etc. New York and London: Hill Publishing Co. Cloth; 4½ × 7 ins.; pp. 198; 47 illustrations in the text. $1.

It is evident that this small volume was intended for practical men, the engineman or the superintendent of the smaller boiler plant, but there is much in it for the technically educated engineer whose recourse to chemistry is only intermittent and of short duration. The student of the three most important factors in the operation of a boiler room, fuel, water and oil, is led through those elementary, theoretical parts of inorganic chemistry, most closely associated with the processes of steam making, into the use of apparatus and chemicals. A brief line of experiments is given to assist in the familarity of manipulations.

After these 40 pages the book narrows down to the particular field indicated by the title. The composition of various fuels is first shown. Sections of this particular chapter also treat of the analysis of solid and liquid fuels. Chapter V. is entitled "The Regulation of Combustion: Gas Analysis." In this chapter are briefly described the common methods of examining flue gases by chemical analysis and the calculations necessary to get the experimental data into desirable form.

In the following chapter, under the general subjects of boiler scale and corrosion, the composition and effects of hard feed waters is set forth with suggestions of remedies. Experiments are prepared to show the relative rusting of iron in various solutions similar in nature to poor feed waters. There is briefly suggested twice the protection of boiler tubes and plates by the suspension, in contact with the iron and with the water, of metal that is electrochemically positive to iron. The corrosion of iron is stated as a fundamentally electrolytic process only in cases where a substance electrolytically negative is in contact with it. The much attacked "carbonic-acid theory" of corrosion is set forth briefly.

The remainder of the book, about one-third, is given up to a consideration of oils of all kinds. Methods of testing and distinguishing are simply explained. In the case of mineral oils, these are the viscosity, specific gravity, acidity, chilling point, flash point and fire tests. In the case of vegetable oils there are several additional tests such as the Valenta (solubility of oils in glacial acetic acid), Elaidin (with nitrous acid to classify oils into drying, semi-drying and non-drying

There is a large amount of new and important matter on up-to-date subjects in the third edition (1908) of

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(2) **To bring into clear relief the underlying principles of economic operation** with a view to the practical usefulness of this information to the employee in securing better results in that portion of the field under his direction; also to give him a clearer general understanding of the science of railroading, and so fit him for further promotion. In order to make the information available to as many as possible ,the use of mathematics and technicalities has been avoided to the utmost.

SYNOPSIS OF CONTENTS

PART I.—ORGANIZATION:

A general discussion of the principles of organization and the objects to be achieved thereby. The difference between Divisional and Departmental Organization is indicated, together with the relative advantages and disadvantages of each. An ideal organization (based very largely on that of the Pennsylvania Railroad) stating in considerable detail the duties of the principal positions on a railroad is given.

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Statistics showing the number of railroad employees of the different classes in the United States, information in regard to employees' Relief Associations, Railway Relief Departments, Railway Savings and Insurance Departments, and other means for caring for the interests of the employees are shown. The subject of education and discipline of employees is discussed with a view to illustrating the underlying principles and the objects to be attained.

PART III.—ACCOUNTS AND ACCOUNTING:

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PART IV.—REPORTS:

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groups), Maumené (rise of temperature on treatment with sulphuric acid), etc. There follows ten pages on the sources, properties and uses of the more important non-mineral oils and on the choice of suitable lubricants. Finally, there are tables of the melting points of metals and salts, comparison of thermometer and hydrometer scales, properties of certain oils, etc.

If there is any criticism to be made of the book it is that to read or study it intelligently probably a somewhat better knowledge of inorganic chemistry is necessary than even a good engineman or the superintendent of a small shop may be expected to possess. Some persons might, however, consider such a condition of things an incentive to the acquisition of the better knowledge.

Census Statistics of Cities.

STATISTICS OF CITIES HAVING A POPULATION OF OVER 30,000, 1905.—Special Reports, Bureau of the Census. [Prepared under the direction of Le Grand Powers, Chief Statistician.] Washington, D. C.: Department of Commerce and Labor, S. N. D. North, Director. Paper; 10 × 12 ins.; pp. 372; tables.

Considering the many and great difficulties incident to collecting and compiling statistics of American cities, the large amount of valuable material here presented reflects great credit on the Bureau of the Census. Moreover, the continued improvement in successive bulletins of municipal statistics shows some of the many advantages of having a permanent Census Bureau.

The 154 cities included in the returns here given had an aggregate population of some 22,200,000 on June 30, 1905. Inasmuch as this population is at least a fourth of that of the whole United States and comprises the larger part of the total population living under wholly urban conditions, and since it is frequently said, and with much truth, that the city is the great problem of the day, a complete statistical exhibit of the governmental activities of these 154 cities would be of great value. Unfortunately, in the present state of municipal accounts and statistics, anything like such an exhibit is quite out of question. Judging from the fact that more than two-thirds of the volume before us is composed of financial statistics it would appear that such are more readily available than are the physical statistics of cities. The alternative inference is that the Census Bureau considered either that (1) financial statistics would be of more service than would physical or else (2) that a greater demand for them existed. Our own opinion is that, with a predisposition towards financial rather than physical statistics, and finding the former more readily available than the latter, the Census Bureau is hardly giving due consideration to either the value of or the demand for physical statistics. We express this opinion with hesitation, knowing full well how difficult it is to secure reliable physical statistics of municipalities. And we feel compelled to add that if engineers and superintendents of various classes of public works find in this bulletin far less than they wish regarding the nature and extent of engineering and similar works they are themselves largely to blame for the deficiency.

There is this to be said in favor of concentrating efforts largely upon financial rather than physical statistics: There has been, for some years past, a well organized and quite extensive effort to improve municipal accounting. Accounting schedules, framed by a committee of the National Municipal League, have been welcomed and utilized by many cities. Now, although several societies devoted to municipal public works have framed schedules for corresponding physical statistics, very few city engineers or water-works superintendents have taken the pains to make up their annual reports accordingly. Under such conditions it is not surprising that the Census Bureau has given more attention to the financial than to the physical statistics of cities. Moreover, where so much educative work must be done as is called for in the field of municipal statistics it is wise to concentrate one's main efforts on a well-chosen field with the hope of improving conditions there and ultimately securing at least some approach to the ideal. Meanwhile, what can be wisely done in other fields will depend largely upon the ease with which they may be entered. Tentative efforts may be made in all promising directions, and here and there a bold sally may be ventured. Such a sally was made, for the present bulletin, into the sewerage and sewage disposal field, with a result that indicates how very much sewerage statistics must be improved before complete and comparable figures can be gathered.

When, in addition to what has already been said, we add a few more words of explanatory comment we think it will be evident that in giving far more attention to financial than to physical statistics, thus far, the Census Bureau has had much to justify it. In conjunction with and as an extension of the work of the National Municipal League Committee on Uniform Municipal Accounts and Statistics the Bureau of the Census has evolved a system of municipal accounting of general applicability to any city in the country. By accentuating financial statistics the Census Bureau is bringing this system to the attention of accounting officers and is greatly aiding the movement for uniform municipal accounts. About half of the text introductory to the present collection of statistics consists of a remarkably concise analysis, with definitions, of the principles of municipal accounting, applicable to American conditions.

It should not be inferred from our remarks on the preponderance of financial statistics that the only portion of the bulletin of use to engineers and superintendents of municipal works is the relatively small remainder devoted to physical statistics. The engineer and executive officer is deeply interested in a wide range of municipal financial statistics and will find in the financial tables here given much information of interest and value.

A more specific idea of what the volume contains will now be attempted. There are 47 tables, some of them extending over many pages. The statistics of the 154 cities are arranged in four groups, according to the size of the cities. Where feasible, totals for all the cities and for those in each group are given.

The first table gives dates of "latest incorporation"; populations in 1905, 1904, 1903, 1900 and 1890, and areas of land, in acres, on June 1, 1905, and also areas annexed since June 1, 1905, all in land, water and total areas. The second table gives payments, receipts and cash balances; first in totals, then for such divisions as general government, schools, libraries, water-works and sinking funds. Obviously, it is impracticable to describe each table in detail. About thirty tables are devoted to the various financial transactions of the cities during the year and to the status of debt obligations and of assets at the close of the year. Assessed valuations of property, the basis of valuations and per capita figures for valuations, taxation, school and some other classes of expenditure are given. The financial operations of industrial or revenue-producing plants are set forth in some detail and in summary in one table, and another table is devoted exclusively to water-works; the latter table gives the year the works were built and the mileage of mains.

The tables of physical statistics, fifteen or so in number, deal with municipally-owned gas and electric works (but scantily), with fire departments and fire losses, with streets and street cleaning, railway grade crossings, sewerage and sewage disposal, street lighting, parks and playgrounds, and with building permits, besides police, court and other statistics.

Notes explaining and in some cases supplementing the tables occupy some fifty pages of introductory text. Included in this supplementary text are interesting summary statements regarding franchise taxes and allied payments by public service corporations, and also regarding taxation methods and rates in various cities.

An appendix prepared by Mr. M. N. Baker, of the editorial staff of this journal, presents a considerable amount of sewerage and sewage disposal data, which, for various reasons, could not be tabulated. The percentage of manufacturing wastes to the total dry-weather flow of sewage, percentage of sewage pumped, kind of purification works, the natural waters into which sewage is discharged, and lawsuits due to methods of sewage disposal are here treated. A historical and descriptive sketch of the sewage works of Worcester, Mass., is included. The census returns on sewerage and sewage disposal, it may very properly be stated at this point, forcibly illustrate the difficulties in the way of collecting physical statistics of cities. For only 41 of the 154 cities was total volume of sewage reported, and many of the returns were only approximate estimates.

As showing what sewerage and sewage disposal statistics are desirable and possible, there is reprinted, as Appendix B, a summary of such statistics for Worcester, Mass., prepared by Mr. Harrison P. Eddy [then] superintendent of sewers for Worcester. The summary follows the recommendations of a committee of the sanitary section of the Boston Society of Civil Engineers.

The utility of this bulletin might have been increased with very little additional labor by including a table or two of comparative figures designed to give a general idea of how well the various cities are provided with readily comparable municipal facilities. The initial column in one such table might be total street mileage; the second column, mileage of improved or paved streets; the third, percentage of improved to total streets; the fourth and fifth, percentages of sewer and water-main mileages to one or the other of the street mileages; and so on for other statistics comparable on a mileage basis. Another table, perhaps, might have total city area as its initial or basal column.

An attempt to show the relative extent to which different kinds of street lights are used was made in the form of three small tables, printed in the introduction. These show (1) the total number of cities reporting arc and incandescent electric lights, the totals for Welsbach and for other gas lights, and also the totals for vapor and for oil lamps; the same specified kinds of lights (2) per 10,000 population and (3) per 100 miles of streets. It cannot be learned from these summaries how many cities rely wholly upon any kind or combination of kinds of lighting, except that all of the 154 cities have arc lights. More useful figures than numbers of lights of various classes per 10,000 population and per 100 miles might have been given, particularly in view of the fact that total populations and total street mileages, instead of actual populations and actual mileages served by each class of lights, are used as divisors. Of what value is it to anyone to know that in cities of 300,000 and over there is less than an average of 0.1% oil lamp per 10,000 population and 0.6% oil

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lamp per 100 miles of total streets? If we could know how many oil and other lamps are used per mile (not per 100 miles) of streets actually lighted something more than the curiosity of the ultra-curious would be served. These averages, however, are not quite as absurd as some census figures published before we had a permanent Census Bureau, giving *by individual cities* the per capita cost of oil and vapor lamps, based on total population.

We have noted this bulletin at great length because it contains much and should, and in future issues doubtless will, contain more material of great value to engineers. We question whether previous bulletins have been as widely used by engineers as would be expected—due in part to the fact that much of the information they most desire has been absent and partly to a lack of knowledge of the existence and value of the bulletins. The number of engineers, water, sewer and street superintendents, commissioners of parks, and the like, who might profit by just the right sort of city statistics is far greater than the number of officials chiefly interested in the financial statistics that predominate in the present bulletin. But if engineers and works superintendents want more physical statistics they should not only make their wants known to the Bureau of the Census but they should also complete and systematize their records so as to make possible the collection of reliable and comparable statistics for all the various works departments of our cities.

AUSBAU VON WASSERKRAEFTEN (Section 1).—Prepared and edited by Th. Koehn. 13th Volume of Part III (Der Wasserbau) of Handbuch der Ingenieurwissenschaften. Leipzig, Germany: Wilhelm Engelmann. Paper; 7¼ × 11 ins.; pp. 544; 124 illustrations in the text and 44 plates. 28 marks; American price, $11.20.

About half of this volume is devoted to descriptions of some two dozen hydraulic power plants generating electric energy. This is to be supplemented by further descriptions in the second volume, where will also be given a discussion of the design and construction of the several elements of water-power plants. The first half of the present volume contains statistical matter on water power, notes on laws governing hydraulic development, and a treatment of the hydrological and economic studies preliminary to a hydraulic power enterprise.

Mining Law.

MINING, MINERAL AND GEOLOGICAL LAW.—A Treatise on the Law of the United States Involving Geology, Mineralogy and Allied Sciences as Applied in Mining, Real Estate, Public Land, United States Customs and Other Litigation, Also the Acquisition and Maintenance of Mining Rights in the Public Domain and Obtaining Patents for Mineral Land under the United States Mining Laws. By Charles H. Shamel, Ph.D., of the Illinois and Michigan Bars. London and New York: Hill Publishing Co. Cloth; 6 × 9½ ins.; pp. 627; 103 illustrations in the text and 1 folding sheet. $5.

From its intimate relation to that fundamental of wealth, real property, the practice of mining is of necessity more closely connected with the law than any of the other engineering professions, whose relations with legal principles, outside of the observances common to all who are law-abiding, are mostly confined to contracts. Primarily, the laws of mining in the United States are designed to protect property; they have originated out of common sense rules formulated in pioneer camps, by fortune-seeking men who were confident enough in their own good star to make laws ensuring to the finder whatever treasure prospecting might bring him. These rules, tempered by the common law of the land, became in time the mining law upon the statute book, and, because they are the outgrowth of the practical knowledge of the miner, the man who would enforce them or understand them must have more than an ability to comprehend legal phraseology. They are based upon natural phenomena as well as upon legal precedent and the geologist as well as the judge is needed to interpret them correctly.

With this idea in view Mr. Shamel has written a book alike for the lawyer who wishes to understand the scientific features of a case and for the engineer who is trying to conduct his operations in accordance with the statutes. The greater part of the work is taken up with citations of specific cases and reproductions of the federal and various State statutes.

A preliminary portion, however, is devoted to a treatment of the theories of geology and mineralogy, and in connection with each point of the law, the geologic principles involved are explained. The following chapter headings will indicate the dual nature of the material: Geology and Allied Sciences; Property in Minerals; Legal Definitions of Mineral and Ore; Theories of Ore Formation and Classification; Public Domain and Mining Laws; Acquisition of Mining Rights; Legal and Scientific Definition of Vein, Lode, Apex, Strike, Dip, etc.; Extralateral Rights; Tunnels; Placers; Water; Miscellaneous Uses of Geology in Law; Forms and Procedure for Locating Mining Claims; Classification of Rocks and Geological Formations; United States Mining Laws and Land Office Rules. An excellent bibliography of the best and latest books on geology, metallurgy and mining law follows the main text.

L'AUTOMOBILE A ESSENCE: Principes de Construction et Calculs. (The Gasoline Locomotive: Principles of Construction and Calculations).—By Ed. Heirman, Civil Engineer. Paris: Ch. Beranger, 15 Rue des Saints-Peres. Cloth; 6½ × 9½ ins.; pp. 256; 70 illustrations in the text.

This is not a popular or descriptive work on the automobile, and it contains not a single picture or view of such a machine. It is devoted entirely to the scientific side of the design of automobiles, and the theoretical principles or conditions which have to be considered in preparing such a design. The first part deals with the resistances to traction, including the influence of the springs, journals, grades, curves, etc.; and also with the resistances affecting acceleration, giving formulas for the time and distance necessary for a given acceleration. The motor or engine is next dealt with, including the theory of the gasoline engine, the fuel, the carburetor, the cooling of the cylinders by air and water, the equilibrium of engines with two to six cylinders, and the calculation of the power. It also treats of the flywheel effects, and the use of brakes. The next part is devoted to the clutches, transmission gears, speed changes and differential gears. It has also chapters on brakes, spring rigging, and steering arrangements. The book is very largely mathematical, being full of formulas and diagrams. As already stated it deals exclusively with the theoretical side of the design of automobiles driven by gasoline engines.

WOOD PIPE.—Wyckoff Supply Co., Elmira, N. Y. Paper; 6 × 9 ins.; pp. 79; illustrated.

While primarily designed as a trade catalog, this pamphlet contains a considerable amount of general information on the manufacture and use of wood pipe, besides other useful data on conduits of various materials.

PUBLIC-ROAD MILEAGE, REVENUES, AND EXPENDITURES IN THE UNITED STATES IN 1904. By Maurice O. Eldridge, Chief of Records, Office of Public Roads. Bulletin No. 32, Office of Public Roads. Logan Waller Page, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 100; two illustrations in the text.

Besides statistics showing by states and counties the character and extent of public roads, the expenditures therefor, and the way in which the money is raised, this interesting bulletin contains a synopsis of the road laws of various states and a tabular comparison by states of the percentage of improved roads, the value of farm lands, and the value of rights of way. It is a pity that the figures are not more recent, but it is only fair to state that the bulletin was issued Aug. 31, 1907; and in addition it is, of course, obvious that the collection of such statistics for the first time in the history of the country was a long and difficult task.

REPORT UPON SMOKE ABATEMENT.—An Impartial Investigation of the Ways and Means of Abating Smoke; Results Attained in Other Cities; Merits of Patented Devices. Together with Practical Suggestions to the Department of Smoke Abatement; the Steam Plant Owner and the Private Citizen. Syracuse, N. Y.: Chamber of Commerce (John A Mathews, Chairman Committee). Paper; 6 × 9 ins.; pp. 42.

HOW TO BURN ILLINOIS COAL WITHOUT SMOKE.—By L. P. Breckenridge. Bulletin No. 15, Engineering Experiment Station, University of Illinois. Urbana, Ill.: The University. Paper; 6 × 9 ins.; pp. 44; 11 illustrations, mostly in the text.

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these bulletins is semi-popular and somewhat local in character, but it is nevertheless a valuable presentation of the subject and contains information that will be useful anywhere.

The second bulletin is more scientific in character than the first, and relates chiefly to studies of Illinois coal; but it also is of general use outside of Illinois. Each bulletin is well worth obtaining and studying by those interested in the subject.

Engineering Contracts.

SPECIFICATIONS AND CONTRACTS.—A Series of Lectures Delivered by J. A. L. Waddell, C. E., D. Sc., LL. D., Author of "De Pontibus," etc. Including Examples for Practice in Specifications and Contract Writing. Together with Notes on the Law of Contracts. By John C. Wait, M. C. E., LL. B., Author of "Engineering and Architectural Jurisprudence," etc. New York: The Engineering News Publishing Co. Cloth; 6 × 9½ ins.; pp. 174. $1, net.

The scanty literature of Engineering Contracts is measurably enriched by Waddell & Wait's new work. The student or beginner will find in Mr. Waddell's four chapters a full presentation and very sound discussion of a number of typical contracts, embodying comments on many points of trouble or difficulty, comments drawn from long experience in engineering work. The older engineer, on the other hand, will find in Mr. Wait's "Notes on the Law of Contracts" much safe advice as to the legal effect and relation of the chief "general clauses" of contracts and specifications. Both sections taken together seem sufficient to enable the engineer, with the help of good judgment and a rigid spirit of fairness, to produce an excellent contract for any piece of construction work with which he may be charged. More than this: several references of Mr. Waddell's to the desirability of drawing a definite contract between owner and engineer, covering specifically the amounts and periods of payment, should help to make the engineer's labors more profitable.

This volume is made up of two lectures (or two series of lectures? "A Lecture," p. 1; "this series of lectures," p. 47) delivered by Mr. Waddell before senior college students, one dealing with specifications, the other with contracts, supplemented by two series of problems in specification writing and contract drawing; and Mr. Wait's chapter "Notes on the Law of Contracts." Both authors possess an excellent style, and are thoroughly familiar with their respective subjects. Some trouble will be experienced by the reader in following through the intermingled quotations and comments in Mr. Waddell's chapters. The quoted parts are set off only by unobtrusive quotation marks, instead of being either indented or set in smaller type. In one or two instances the omission of a quote mark obliterates the demarkation between quoted clause and discussion.

A separation into Specifications and Contract is attempted by Mr. Waddell, with not very good success. Indeed he does not give a definition by which the distinction may be made. It is known, of course, that the real contract is composed of the drawings, the technical specifications (those clauses which prescribe tests, define the functions of inspectors, prescribe methods of treating materials, etc.) and the formal agreement and administrative clauses. The fact that (the plans being separate) some of the written agreement is put in one document and called Specifications while the remainder is grouped together as the Contract, does not affect the essential unity of the whole. Mr. Wait says clearly (p. 131):

> The specifications are not strictly an independent document to be distinguished from the contract, but they are a component part of the contract,

but he follows this with a definition of Specifications which, however, is not broadly applicable:

> [The specifications are] the part descriptive of the structure and of the labor and materials comprising it. The plans are mere graphic specifications * *

Later (p. 150) Mr. Wait gives a more useful definition by stating what clauses it is generally better to segregate from the Specifications as the formal Contract.

We might perhaps attempt to distinguish between Contract and Specification in this way: the Specification includes all the information necessary to be furnished to intending bidders, while the Contract is made up of those additional formal clauses needed to make a binding agreement and the statement of the terms of the accepted bid. This would throw nearly everything into the Specifications, and make them very unwieldy for the use of engineers and inspectors. On the other hand, we might group as Contract everything except the statement of technical requirements, the latter forming the Specifications. This, however, would split into separate parts the material composing the instructions which the field engineers and inspectors and the contractor's agents and foremen must constantly consult. If a division is made, therefore, it must be a compromise division; it cannot be a rational one, nor one suited to all the purposes which the document must fulfill.

In other words, there is no natural division into Contract and Specifications for the purposes of the discussion which Mr. Waddell presents, and, consequently, the division of the discussion into two separate chapters is entirely arbitrary. Many of the "general clauses" discussed in the chapter on Specifications are parallel with other clauses discussed under Contracts. The reader must study both chapters simultaneously. But the typical specimens chosen for presentation maintain a fairly good distinction, since those given under Specifications are in the main technical, while those given under Contracts are in the main legal documents.

There has hitherto been no treatise on the art of writing technical specifications, using this term in the narrowest sense to include only those clauses which define the result whose accomplishment is the object of the contract (general statement of work to be performed, description of quality of material required, definition of workmanship, manner of determining this performance by inspection and test, etc.). Such a treatise would be a very useful thing, for specifications as found in practice are written in pure-by haphazard fashion and exhibit the widest variety both in scope, in arrangement, in reasonableness and in completeness. One man thinks it proper to make his specifications describe the required work in such detail that "one skilled in the art" could reconstruct the entire set of drawings from them; another, restricting himself to those matters not stated or defined by the drawings, brings together a heterogeneous compilation of clauses which are confused in arrangement, obscure or ambiguous in spots, and both burdensome and incomplete; still another will specify an ideal perfection of work beyond anything he can ever obtain or expect to obtain, or else he occupies much space with the description of procedures and qualities which are mere commercial practice, but forgets to specify the desired qualities in essential or doubtful matters. These various results are in large part chargeable to the absence of a monograph on the principles which should govern the preparation of a technical specification.

Mr. Waddell, in his chapter on Specifications, seems to have intended to meet this need in part at least. Unfortunately, he makes little or no endeavor to analyze the matter and bring out the governing principles, but relies on the presentation of specimen clauses to teach what should be included and how it should be stated (and by elimination also what should be omitted). A few general rules are given, in the introductory paragraphs, but their application is not shown. Occasionally the general rules or cautions are not carried into practice in the specimens cited. Thus, the rule is given (p. 3) that specifications should leave the method to the contractor and dwell upon the end to be attained. But in specifying steel (p. 24), not only are chemical analysis and complete physical tests specified, including bending and drifting tests, but open-hearth steel is demanded and Bessemer prohibited; the reasons for the restriction are not stated, and the reader is left in doubt as to why Bessemer would not be perfectly satisfactory if it stood the tests specified.

This criticism is hardly fair, perhaps, in view of the fact that the book was not written as a book, but grew out of a series of lectures. It will be permissible, however, to remark that the two main chapters of Mr. Waddell's section are each so long that much clearness would have been gained by subdividing them into several chapters. In default of this, the reader is called upon for somewhat closer study of the text, which, perhaps, is no great evil.

TURNEAURE and MAURER

Principles of Reinforced Concrete Construction

8vo, viii + 317 pages, 11 plates and 130 figures. Cloth, $3.00.

JOHN WILEY & SONS
43 and 45 East 19th St., New York City

BULLETINS, U. S. GEOLOGICAL SURVEY.—George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 325: A Study of Four Hundred Steaming Tests Made at the Fuel-Testing Plant, St. Louis, Mo., in 1904, 1905 and 1906. By Lester P. Breckenridge. Pp. 196; 76 illustrations in the text.

The material forming this bulletin is of two fairly distinct classes, one on the behavior of coal fuels and the other on the behavior of boilers as steam generators. The former embodies the practical lessons of 400 tests on two identical Heine water-tube boilers; the latter contains theoretical discussions and mathematical deductions of complicated formulas in which appear physical constants whose values it is sought to approximate from these 400 steaming tests and from additional experiments. In discussing the use of different coals, the characteristics of the coal are described in considerable detail. The necessary methods of handling and the results of use are outlined. In this connection it is shown that the combined efficiency of a furnace and boiler was little affected by the temperature of fuel combustion; that a high CO content in the flue gases was always a sign of incomplete combustion and low efficiency, although high CO_2 did not always indicate a high efficiency; that the rate of combustion was affected by the chemical composition of the coal by thickness of fire bed and character of clinker formation; that coal in sizes from ¼ to 1½ ins. burned more rapidly than either larger or smaller sizes; that steaming capacity of the boiler depended almost directly on the rate of combustion in the furnace; that ash in coal up to 15% did not appreciably affect capacity or efficiency; that sulphur was not detrimental to the steaming value of coals except when it existed in such compounds as promoted the formation of clinker; that briquetted coal could be burned at a higher rate of combustion than ordinary slack and with little or no smoke, etc.

Practical Cement Testing

By W. PURVES TAYLOR, M. S., C. E.
Engineer in Charge of Philadelphia Municipal Testing Laboratories.

The book is so complete that it can be put in the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. The wealth of photographs and line cuts furnish the pictorial examples of how to conduct cement tests, and the 300 pages of texts are so explicit that even the most inexperienced man can soon learn the art of cement testing. Yet the book has not a superfluous paragraph. The list of chapters includes: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13) Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement than Portland, (16) Specifications (The Author's, Am. Soc. C. E.; Am. Soc. Test. Mtls.; Soc. Chem. Indust.; Corps Eng. U. S. A.; British Standard, Can. Soc. C. E.).

Cloth, 6 × 9 inches; 330 pages; 142 illustrations; 58 tables; $3.00 net, postpaid.

THE MYRON C. CLARK PUBLISHING COMPANY
357 Dearborn Street, Chicago

The theoretical discussions mentioned are in general extensions and developments of theories of the action of hot gases in boilers, advanced by John Perry, Past President, Inst. E. E. In brief, these theories are that the true boiler efficiency depends on (1), the temperature difference between the gases on one side of the tube and the water on the other side; (2), the density of the products of combustion; (3), the specific heat of these gases and (4), the velocity of the gases parallel to the heating surfaces.

The practical results of this study of these 400 tests is largely confirmatory of the expressed opinions of many engineers. The application of the theoretical part of the bulletin, however, is much more involved, is quite iconoclastic and will not be readily accepted as they stand.

HYDRAULIC AND PLACER MINING.—By Eugene B. Wilson. Second Edition, rewritten. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 4⅝ × 7½ ins.; pp. 355; plates, text illustrations and tables. $2.50.

This book is the second edition of one first published in 1898. The author states that the text has been entirely rewritten to include many new methods and improvements in machinery.

The first chapter deals with the geology of placer deposits of gold, particularly as illustrated by locations in California, North Carolina and Alaska. Accurate and loose methods of prospecting placer deposits are indicated in this chapter also. In the second chapter the history of all kinds of mining operations involving the use of water is quickly disposed of and the author narrows his efforts thereafter to methods of recovering gold from placer deposits by those hydraulic methods commonly known as "hydraulicking."

The author sketches in Chapter III. the development of pan, cradle, and sluice in California, the home of true hydraulicking. In a chapter on Riffles and Dumps there is given much detail of practical design of the obstacles in sluices necessary to intercept the gold particles. The section on water supply is a mixture of practical details and theoretical deductions about dams, water measurement, ditches, pipe lines, elevators and nozzles.

The sections of the volume treating the exploiting and developing of placers and gold dredges are perhaps the most useful in the book, as evidently the author has compiled data and practice from many scattered sources. Two chapters contain a digest of the United States mining laws and of the Canadian regulations for the Yukon. The text closes with tables for determining the gold value per ton of quartz or per cubic yard of gravel and for computing the flow of water through open channels, pipes, bends, nozzles, orifices, etc.

While there is much desirable information scattered between the covers of this volume there is great need of careful and consistent editing. The subject matter could have been arranged in a better and more logical sequence than has been done. The book gives the impression of being the occasional or hasty work of one busy with other duties. Then, too, the matter on hydraulic engineering problems might to a considerable extent have been omitted, as it is fragmentary and empirical in the methods of presentation and would be of service only to those who would be expected to use the standard works on hydraulic engineering when it became necessary to consult tables or review text.

FABRIKORGANISATION, FABRIKBUCHFUEHRUNG UND SELBSTKOSTENBERECHNUNG DER FIRMA LUDW. LOEWE & CO., ACTIENGESELLSCHAFT.—By J. Lilienthal. With a Preface by G. Schlesinger, Professor in the Technical College at Berlin. Berlin, Germany: Julius Springer. Cloth; 7½ × 10¾ ins.; pp. 220; 10 folding sheets. 10 marks; American price, $4.

If we regard manufacturing as a dominant feature of modern existence, we at the same time concede a high importance and value to the scientific study of factory management and operation, since this is the logical means of developing the efficiency of manufacturing in general as well as in specific instances. Such study is a very recent thing; while the most successful manufacturers long ago practiced some of its chief teachings, the subject has only very recently been explicitly recognized as capable of general study. But though much may be expected from this new study, we must recognize that it is incapable of fruitful application except on the basis of minute, exhaustive data concerning the operation of a factory as furnished by a thoroughly organized system of shop management and cost accounting. The management of the factory must be in constant touch with every operation, every machine, every workman, both as a unit and as a part of the shop machine, or else the knowledge of theoretical principles remains barren. It is in this light that the record of a bookkeeping and control system as here presented by Mr. Lilienthal becomes of great interest. The Loewe shops are noted as among the most progressive of European machine shops. Their thorough if intricate system of shop management is unquestionably a prime factor herein. The plan of publishing a full description of this system is highly commendable, and suggests the hope that other large and progressive concerns may follow the same plan.

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416 pages 113 illustrations 28 plates Net, $5.00

McGRAW PUBLISHING COMPANY, 239 WEST THIRTY-NINTH STREET, NEW YORK

THE "MECHANICAL WORLD" ELECTRICAL POCKET BOOK FOR 1908.—Containing a Collection of Electrical Engineering Notes, Rules, Tables and Data. Manchester, England: Emmott & Co., Ltd. Cloth; 3¾ × 6¼ ins.; pp. 247; 50 illustrations in the text. 6d., net; American price, 20 cts.

This book presents in small compass a considerable amount of elementary instruction in electrical practice. Necessarily in an attempt of this sort, to compress a great deal of knowledge into a few pages, many data and much information is given largely in empirical ways. The book obviously is not intended for the practicing engineer, but for many mechanicians and mechanical engineers who desire very concise references for the most elementary electrical engineering, it may save searching several texts. Among the sub-divisions of the work there may be noted: systems of units, laws of circuits, laws of electrolysis, design of magnets, direct and alternating-current machinery, electrical machine drives, care of electrical machinery, instruments, storage batteries, electric lighting (including material on the new types of incandescent and arc lamps), etc. There are tables of mechanical and electrical equivalents, of power required and absorbed in driving various kinds of machinery, transmitted HP. of belts, ropes and shafts, weights of copper bars, thermometer scales, metric conversion tables, areas and circumferences of circles and of squares, cubes, and square roots of numbers.

EINFLUSS DER ARMATUR UND DER RISSE IM BETON AUF DIE TRAGSICHERHEIT.—By E. Probst. Reports of the Royal Testing Institution, Gross-Lichterfelde West, Berlin. Berlin, Germany: Julius Springer. Paper; 7½ × 10½ ins.; pp. 144; 9 plates and 77 text illustrations. 15 marks; American price, $6.

MATERIALBEDARF UND DICHTIGKEIT VON BETONMISCHUNGEN.—Unter Berücksichtigung der Zusammenstampfbarkeit der Füllstoffe. By H. Nitzsche. Leipzig, Germany: Wilhelm Engelmann. Paper; 7 × 9¾ ins.; pp. 16; two folding plates in pocket. 1.6 marks; American price, 65 cts.

The monograph of Probst is a detailed report of tests of concrete beams reinforced with plain rods and various types of deformed rods. The tests comprise three series: (1) 58 tests on beams 6.3 × 8.7 ins., 68 ins. long, to exhibit the general phenomena of flexure, location of neutral axis, shape of cross-section surface after deformation, actual elongations and compressions, and relation of first cracks to loading and to type of reinforcement, etc. All the beams broke because the steel passed its elastic limit, crushing failure being a subsequent phenomenon. The concrete was 1:2:4, and the reinforcement varied from 1.03 to 1.31%. (2) Tests to determine whether the tension cracks in concrete beams are apt to permit rusting of the steel. A mixture of CO_2, O and water vapor was led into a casing around the beams after the latter had been loaded sufficiently to develop tension cracks. Rusting occurred only when the elastic limit of the steel had been reached or approached, and in no other case. (3) Tests on 50 beams, 6 × 12 × 39 ins., reinforced with a single rod, to produce failure in bond and to determine the bond values. The plain bars gave lower results than the deformed bars, and of the latter the Johnson bars gave somewhat higher bond strength than the others. The bond strength was computed in an entirely novel manner, however. These tests all were made at the Royal Testing Laboratory at Gross-Lichterfelde, Berlin, for the Expanded Metal & Corrugated Bar Co., of St. Louis, Mo. They are well worth study.

The little pamphlet of Nitzsche contains a discussion of the proportioning of concrete to secure greatest density, with two diagrams giving volumetric proportions of sand and stone for given percentage of voids in stone and given excess of mortar.

EXCAVATING MACHINERY FOR DIGGING DRAINAGE DITCHES AND BUILDING LEVEES.—By J. O. Wright, Supervising Drainage Engineer, U. S. Department of Agriculture. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.; pp. 40; illustrated.

This pamphlet reviews the various classes of

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Ten thousand contractors and engineers have bought one book, and a very great percentage have subscribed for the paper edited by the author of that book. We refer to Gillette's "Handbook of Cost Data," and to "Engineering-Contracting," the latter being a weekly periodical for civil engineers and contractors. The "Handbook of Cost Data" has broken all records for the sale of an engineering book, because it is full of detailed costs of all kinds of actual construction. The handbook contains 622 pages, bound in leather, and its price is $4 net, postpaid. "Engineering-Contracting" is $2 a year (52 copies), but for a short time $1 will be accepted for a full year's subscription.

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machines employed in excavating pipe trenches and wide ditches for drainage work, some of the machines being adapted to deliver the excavated material to form levees parallel with the work. The cost of each machine is given, with the cost of operation in some cases. More space is devoted to the dipper dredge than to any other class of machine. A few pages are devoted to a review of the machinery and methods adapted to different conditions.

Publications Received.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Proceedings of the 10th Annual Meeting, Held at Atlantic City, N. J., June 20-22, 1907. Vol. VII. Edited by the Secretary, under the Direction of the Committee on Publications. Philadelphia, Pa.: The Society (Prof. Edgar Marburg, Secy., University of Pennsylvania). Paper; 6 × 9 ins.; pp. 759; folding and other plates, and text illustrations.

ANALYSIS OF ELASTIC ARCHES.—Three-Hinged, Two-Hinged, and Hingeless, of Steel, Masonry, Reinforced Concrete. By Joseph W. Balet, Consulting Engineer. New York: The Engineering News Publishing Co. London, England: Archibald Constable & Co., Ltd. Cloth; 6 × 9½ ins.; pp. 316; folding plates and text illustrations. $3, net.

DIE ASSANIERUNG VON KOEBENHAVN.—Prepared by Messrs. Berg, Bjerre, St. Friis, Gredsted, Heiberg, Hertz, Hoff, Levison, Neergaard, Nielsen (K. M.), Nielsen (H. A.), Nohn, Oellgaard, Schierbeck, Tobiesen and Ulrik, under the supervision of Dr. Th. Weyl. Part 14, Group II., Fortschritte der Ingenieurwissenschaften. Leipzig, Germany: Wilhelm Engelmann. Paper; 7¼ × 11 ins.; pp. 196; 108 illustrations in the text and 21 plates. 15 marks; American price, $6.

BRUECKEN IN EISENBETON.—A Text-book for School and Practice. By C. Kersten. Part II. Arch Bridges. Berlin, Germany: Wilhelm Ernst & Sohn. Paper; 6½ × 9¾ ins.; pp. 147; 356 illustrations in the text. 4 marks; American price, $1.60; or bound in cloth, 4.8 marks and $2, respectively.

BULLETINS, U. S. GEOLOGICAL SURVEY.—George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 321: Geology and Oil Resources of the Summerland District, Santa Barbara County, California. By Ralph Arnold. Pp. 93; 17 plates and 3 text figures.

No. 322: Geology and Oil Resources of the Santa Maria Oil District, Santa Barbara County, California. By Ralph Arnold and Robert Anderson. Pp. 161; 26 plates (one in pocket).

DEPARTMENT OF RAILWAYS AND CANALS (Dominion of Canada).—Annual Report for the Fiscal Period from July 1, 1906, to March 31, 1907. (George P. Graham, Minister of Railways and Canals.) Ottawa, Can.: Pub. Doc. Paper; 6½ × 9¾ ins.; pp. lxiv. + 344; one folding sheet.

FIRE TESTS WITH FIRE EXTINGUISHERS.—Fire Extinguishers Known as the "New Era" Extinguishers, Submitted for Test by Messrs. The Valor Co., Ltd., Aston Cross, Birmingham, and London. The Committee's Report. No. 124, "Red Books" of the British Fire Prevention Committee. London, England: The Committee, 1 Waterloo Place, Pall Mall. (Edwin O. Sachs, Chairman of the Executive). Boards; 5½ × 8½ ins.; pp. 32; 16 illustrations in the text. 2s., 6d.; American price, $1.

THE GAS ENGINE IN PRINCIPLE AND PRACTICE.—Consisting of Articles Published in "Gas Power" and Other Descriptive Matter and Tables. Written and Compiled by A. H. Goldingham, Mechanical Engineer and Expert, Author of "Oil Engines." St. Joseph, Mich.: Gas Power Publishing Co. Cloth; 6 × 9¼ ins.; pp. 105; 107 illustrations in the text. $1.50.

INTERNATIONAL WATERWAYS COMMISSION.—Third Progress Report, Dec. 1, 1907. (O. H. Ernst, Brig.-Gen., U. S. Army, Retired, Chairman American Section). Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 81.

LIST OF WIRELESS-TELEGRAPH STATIONS OF THE WORLD.—Including Shore Stations, Merchant Vessels, and Vessels of the United States Navy. Corrected to Aug. 1, 1907. Navy Department, Bureau of Equipment. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 93; one folding sheet.

LIST OF WORKS IN THE NEW YORK PUBLIC LIBRARY RELATING TO HYDRAULIC ENGINEERING.—(Reprinted from the "Bulletin," November-December, 1907). Paper; 7 × 10 ins.; pp. 102.

THE LUMBER CUT OF THE UNITED STATES, 1906.—Circular 122, Forest Service, U. S. Department of Agriculture. Gifford Pinchot, Forester. (In cooperation with the Department of Commerce and Labor, Bureau of the Census, S. N. D. North, Director.) Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 42; two folding sheets.

MOVING LOADS ON RAILWAY UNDERBRIDGES.—Including Diagrams of Bending Moments and Shearing Forces and Tables of Equivalent Uniform Live Loads. By Harry Bamford, Assoc. M. Inst. C. E., Lecturer on Engineering Drawing and Design, Glasgow University. London, England: Whittaker & Co. (New York: The Macmillan Co.) Flexible cloth; 6½ × 8¼ ins.; pp. 78; 80 figures in the text. $1.25, net.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.—Proceedings for 1906. Edited by The Publication and Library Committee. Max L. Blum, Editor and Business Manager. New York: The Municipal Engineers. Cloth; 5¾ × 9¼ ins.; pp. 212; 52 plates.

NOTES SUR LE COMMERCE INTERNATIONAL, LA NAVIGATION ET LES FINANCES DU BRESIL.—By Dr. Vieira Souto, Professor of Political Economy and of Finances at the Polytechnic School in Rio de Janeiro. (Extract from the work, "Brasil, Its Natural Wealth, Its Industries.") Rio de Janeiro, Brasil: M. Orosco & Co. Paper; 7¼ × 11 ins.; pp. 93; illustrated.

PLANE AND SPHERICAL TRIGONOMETRY.—By A. H. Buchanan, LL.D., Professor of Mathematics, Cumberland University. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5⅜ × 9¼ ins.; pp. 96; 30 figures in the text. $1, net.

A PLEA FOR THE BROADER EDUCATION OF THE CHEMICAL ENGINEER.—An Address by Clifford Richardson, Vice-President and Chairman of Section C for 1907, before the Section of Chemistry, American Association for the Advancement of Science. (Advance Sheets from the Proceedings of the American Association for the Advancement of Science, Vol. LVII., 1908.) Paper; 6 × 9¼ ins.; pp. 16.

PUMPING ENGINES FOR WATER-WORKS.—By Charles Arthur Hague, M. Am. Soc. C. E., M. Am. Soc. M. E. New York: McGraw Publishing Co. Cloth; 6 × 9½ ins.; pp. 372; 113 illustrations, partly in the text. $5.

RAILROAD VALUATION.—By William Z. Ripley. (Reprinted from Political Science Quarterly, Vol. XXII., No. 4.) Boston, Mass.; Ginn & Co. Paper; 5¾ × 8¾ ins.; pp. 577 to 610.

RESULTS OF INVESTIGATION INTO THE COST OF PORTS AND OF THEIR OPERATION.—By Elmer L. Corthell. Brussels, Belgium: Permanent International Association of Navigation Congresses (169 Rue de Flandre). Paper; 6¼ × 9½ ins.; pp. 58; diagrams and one folding sheet.

ROAD DRAG LAW AND RULES FOR DRAGGING.—Bulletin No. 2, Highway Commission, State of Illinois. Edmund J. James, Chairman. Springfield, Ill.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 8; four illustrations in the text.

ROAD MAKING AND MAINTENANCE.—A Practical Treatise for Engineers, Surveyors, and Others. With an Historical Sketch of Ancient and Modern Practice. By Thomas Aitken, M. Inst. C. E., Surveyor to the County Council of Fife, Cupar Division. Second Edition. London, England: Charles Griffin & Co. Cloth; 6 × 9¼ ins.; pp. 525; 167 illustrations, partly in the text. 21s., net; American price, $8.40.

SAP-ROT AND OTHER DISEASES OF THE RED GUM.—By Hermann von Schrenk, Formerly Expert in Charge of Mississippi Valley Laboratory. Bulletin No. 114, Bureau of Plant Industry. B. Y. Galloway, Chief of Bureau. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 37; eight plates.

THE SCIENCE YEAR BOOK.—With Astronomical, Physical and Chemical Tables, Summary of Progress in Science, Directory, Biographies, and Diary for 1908. (Fourth Year of Issue.) Edited by Major B. F. S. Baden-Powell. London, England: King, Sell & Olding, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 153 + 365; illustrated. 5s., net; American price, $2.

SIGNIFICANCE OF THE NUMBERS OF BACTERIA IN WATER AND SEWAGE DEVELOPING AT DIFFERENT TEMPERATURES.—By Stephen DeM. Gage, Biologist at the Lawrence Experiment Station. (Reprinted from the 38th Annual Report of the Massachusetts State Board of Health, 1906, pp. 325 to 349.) Paper; 5¾ × 9¼ ins.; pp. 25; 15 tables.

THE STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS.—Written and Compiled by a Staff of Specialists. New York: McGraw Publishing Co. Flexible leather; 4 × 7 ins.; pp. 1,283; illustrated. $4, net.

STEPS IN CYANIDATION.—By Phillip Argall. (From Proceedings of the Colorado Scientific Society, Vol. VIII.) Denver, Colo.: The Society. Paper; 6¼ × 9½ ins.; pp. 323 to 347.

STRENGTH OF MATERIALS.—A Manual for Students of Engineering. By William Charles Popplewell, Assoc. M. Inst. C. E., Lecturer on Strength of Materials. Theory of Structures, and Hydraulics, at the Manchester Municipal School of Technology. Edinburgh and London: Oliver & Boyd. Cloth; 5½ × 9 ins.; pp. 180; 105 illustrations, mostly in the text. 5s., net; American price, $2, net.

STRUCTURAL DRAWING.—By C. Franklin Edminster, Instructor in Department of Fine and Applied Arts, Pratt Institute, Brooklyn, N. Y. Published by the Author. ("Supplied" by David Williams Co., New York.) Cloth; 8¾ × 7¼ ins.; pp. 148; 74 illustrations, mostly in the text. $2.50.

SURGEON-GENERAL, U. S. NAVY.—Annual Report to the Secretary of the Navy, for the Fiscal Year 1907. (P. M. Rixey, Surgeon-General.) Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 154; three plates.

TESTS OF REINFORCED CONCRETE BEAMS.—Series of 1906. By Arthur N. Talbot. Bulletin No. 14, University of Illinois Agricultural Experiment Station. Urbana, Ill.: The University. Paper; 6 × 9 ins.; pp. 36; 14 illustrations, mostly in the text.

TIDE TABLES FOR THE EASTERN COASTS OF CANADA FOR THE YEAR 1908.—Including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits; and Information on Currents. Issued by the Tidal and Current Survey in the Department of Marine and Fisheries of the Dominion of Canada. W. Bell Dawson, M. Inst. C. E., F. R. S. C., Engineer in Charge. Ottawa, Can.: Pub. Doc. Paper; 6½ × 10 ins.; pp. 49.

THE TRAIN DISPATCHERS' ASSOCIATION OF AMERICA.—Annual Convention, Boston, Mass., June 18, 1907. (J. F. Mackie, Secy., C., R. I. & P. Ry., Chicago, Ill.) Paper; 5¼ × 7¼ ins.; pp. 212; illustrated.

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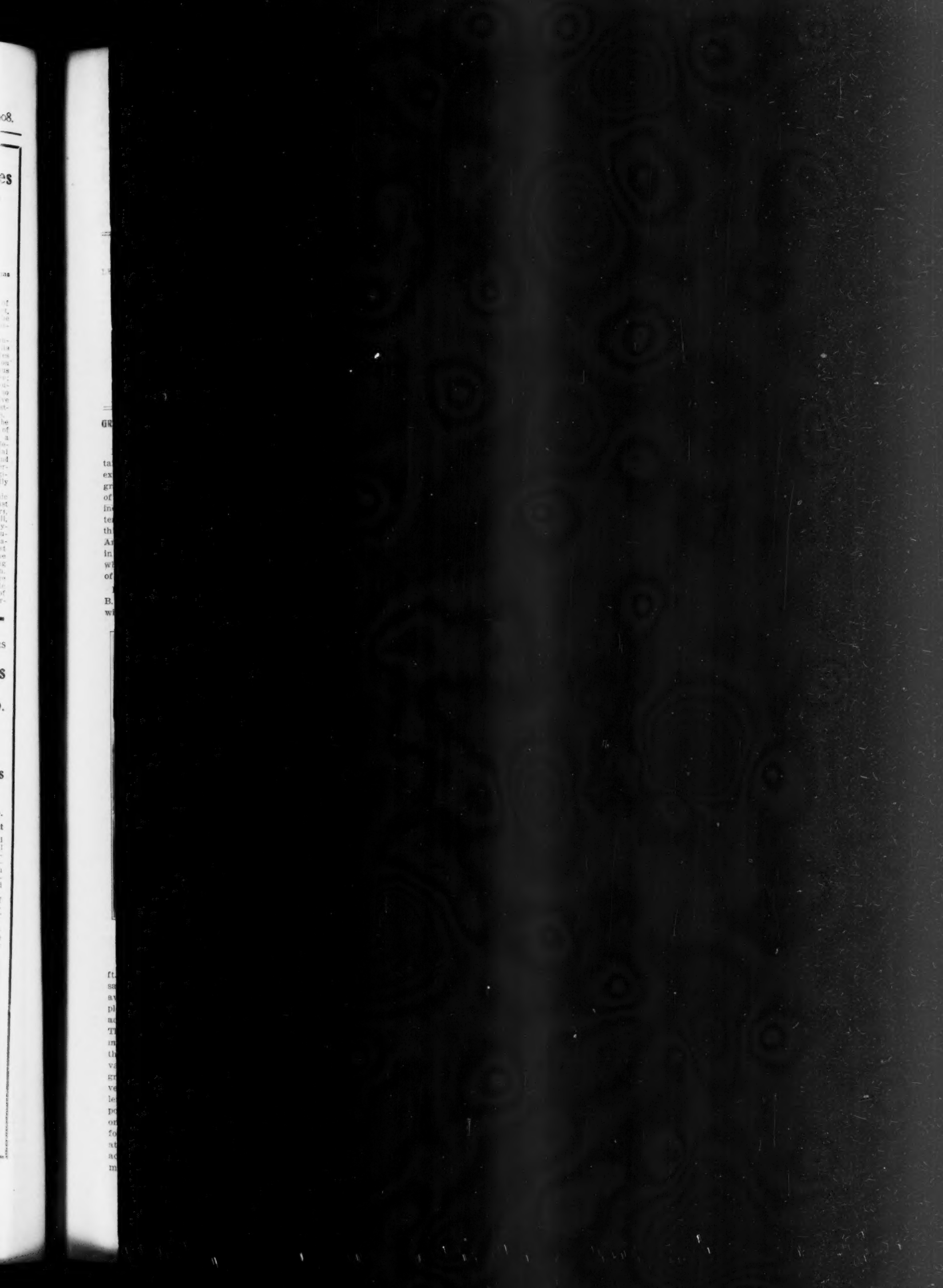
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